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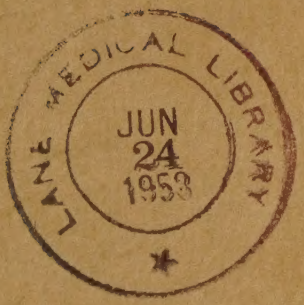
A comparative study of two yaws endemics in South-West Borneo



N. M. VAN DER HOFF

A COMPARATIVE STUDY OF TWO YAWS ENDEMICS IN SOUTH-WEST BORNEO.

A comparative study of two yaws endemics in South-West Borneo

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To *my wife*

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CHAPTER I

GENERAL DESCRIPTION OF THE DISTRICT OF KETAPANG

The examination dealt with in this thesis was carried out in the district of Ketapang (Kebupaten) in the southwestern corner of Borneo (Kalimantan), between 0°30′—3°00′ S. latitude and 110°—111° E. longitude. Ketapang may be compared in size with the Netherlands (34.000 km²) and has a population of about 130.000 (3.8 per km²). It is a very isolated region and practically the only contact with the outer world (Pontianak, the capital of West Borneo) is by way of the sea. The six small rivers intersecting it, roughly follow the borders between the various sub-districts.

The district may, in more than one respect, be divided into two sections: the coastal region and the inland.

In the coastal region the land is low-lying, sandy and marshy; the inland is rather elevated and hilly.

The coastal region is inhabited by Malayans, the population of the inland being mainly Dyaks.

The two regions are separated by a marshy belt, which is impassable to such an extent that all efforts to build a connecting road have failed.

The coastal region comprises two sub-districts: Sukadana — in the north, and Matan Hiler — in the south.

The inland may also be divided into a northern and a southern section: Simpang and Matan Hulu.

The examination described below has been restricted to the southern parts: Matan Hiler and Matan Hulu.

A. Coastal region: Matan Hiler.

a) **Kampongs.** The kampongs (villages) chosen for this examination lie at distances of from 10—28 km south of the district's capital — which also bears the name of Ketapang — and have a population of 6500.

b) **Population.** The total number of people living in Matan Hiler is 35.000 nearly all of whom are Mohammedans. By far the major portion consists of Malayans; furthermore there are about 500 Madurese and some Chinese.

Originally the people of this region were traders, which still shows up in their character, even though the majority has turned to agriculture.

c) **Economy.** The economy is based primarily on the acquisition of rice, which is the staple food in Matan Hiler.

Rice is grown in the l a d a n g s (dry sawahs) but in boom periods the work in the rice fields is readily given up in favour of coconut picking

and rubber tapping. The economic activity therefore is closely connected with the state of the market and is not determined by tradition. Consequently, the standard of living is liable to fluctuations.
At the time when I was working in Matan Hiler the economic situation, and hence the standard of living, was very good, especially during the first part of my stay.
There is of course some differentiation between rich and poor; a very rich class, however, did not exist.
The class of the poor includes the widows and unmarried women that have to provide for a number of children but are doing their utmost to earn their own livelihood. Beggars I have never noticed.
The economy was extremely primitive with little differentiation. Nevertheless, everybody — although poor according to modern standards — could earn enough to make a living. The influence of the Chinese on the economic life, if not negligible, is certainly less than elsewhere on the west coast of the island. Stock-raising is unknown, except among the small group of Madurese (30 % of the population of Sungei Pelang is Madurese) who are good farmers and also have a fair knowledge of stockraising (especially cows).
Fishing villages do not exist in Matan Hiler, although it should be remarked that part of the population regularly goes out fishing on the sea for its own needs.

e) **Soil.** The soil consists of marshland with a sandy ridge here and there. The ridges are preferably used as dwelling places whereas the marshy and lower-lying parts are used for growing rice.

d. **Housing.** The houses, and this applies to the whole district of Ketapang, are built on piles. The space under such a pilehouse (k o l o n g) varies between 0.75 and 1.50 M in height and is a haunt of small flies of the family Siphunculina funicola, which are a real plague in the coastal region examined.
The houses being built on piles the floors are covered up, which is a great advantage considered from a hygienic point of view.

f) **State of health.**

1. Malaria. In the low-loying coastal region malaria is not nearly so prevalent as inland where it is a true endemic.

TABLE 1.

Splenic and parasite indices for Matan Hiler.

Number of persons examined	7634
Number of splenic enlargements	1131
Splenic index	15.4
Highest splenic index	25.4
Lowest splenic index	8.8
Number of thick drops tested	4714
Number of positive thick drops	524
Parasite index	11.2
Highest parasite index	17.0
Lowest parasite index	5.8

In the coastal kampongs the splenic index was determined in 1482 people. The number of persons with plenic enlargement was 183, which gives a splenic index of 12.3.

2. Ankylostomiasis. Exact figures on the prevalence of ankylostomiasis cannot be given owing to a lack of reliable information. According to the experience gained in the polyclinic at Ketapang it may be taken, however, that ankylostomiasis occurs along the coast, although not frequently and certainly much more rarely than inland. This is in agreement with the favourable haemoglobin content found.

3. The determination of the **haemoglobin** content may be a valuable aid in judging the general state of health. It furnishes an indication of the gravity of a malaria endemic and of the prevalence of ankylostomiasis; in addition the haemoglobin content may be considered an indirect measure of the state of nutrition.

In this examination use was made of a Tallquist scale. Provided the number of persons examined is large enough, this method, if carried out properly, gives very reliable data, especially when the examination is made for comparative purposes.

In judging the absolute values, however, some care should be exercised. On the whole, the absolute values listed below for the age groups over ten are fairly reliable, whereas the figures given for children under ten, and especially those for the very young and babies, are too low. This is due to the fact that the drops tested were too small through which the filter paper was not completely soaked, with the result that the colour was lighter than is ought to have been. I did not try to correct this error because a good test would have made the children feel uneasy and might have disturbed the mothers' confidence in the examination. In addition there is the fact that the knowledge of the haemoglobin content of small children is not essential for the following part of this study. Nevertheless, the haemoglobin content was determined as accurately as possible.

This was achieved in the following way:

a) the drops were always taken by the same person;
b) comparing the colour of the soaked filter paper with the scale was also done by one and the same person;
c) all comparisons were made against the same scale;
d) the drops were absorbed in the same type of filter paper.

The haemoglobin contents, measured in 628 people of the coastal region are listed in table 2.

4. State of nutrition. In this connection the following facts should be noted: hunger oedema has never been observed; in children only a few cases of serious under-nourishment; xerophthalmia very rare. The protein content of the food is rather low; especially greens are not eaten sufficiently. Normally, there is enough fresh and dried fish; animal proteins are provided by chickens, goats and occasionally cows, but these are usually reserved for festive occasions. On the whole, nutrition may be said to be sufficient, although it is not what it ought to be.

TABLE 2.

	Persons examined	Haemoglobin content						Average Hb-content	Percentage with Hb-content 60 and lower
		90	80	70	60	50	40		
Men of 19 and older	132	9 6.8%	89 67.4%	32 24.3%	2 1.5%	— —	— —	77.2	1.5
Women of 19 and older	147	2 1.4%	82 55.7%	57 38.7%	3 2.1%	3 2.1%	— —	73.4	4.1
Men from 11—18	54	1 1.9%	33 61.2%	17 31.4%	3 5.5%	— —	— —	75.9	5.5
Women from 11—18	44	— —	24 54.6%	18 40.8%	2 4.6%	— —	— —	74.8	4.5
Children from 3-10	202	— —	38 18.8%	112 55.3%	50 24.8%	2 1.1%	— —	69.7	25.8
Children from 0-2	49	— —	2 4.1%	20 40.8%	22 44.8%	5 10.1%	— —	63.8	55.0

The haemoglobin contents, measured in 628 people of the coastal region.

5. **Increase in population and mortality.** The figures giving the increase in population are recorded in the table on page 17. This examination was very difficult owing to a lack of an official registration. Consequently the information needed had to be collected as follows. Every marriageable woman (married, single or widow) was asked how many children she had borne and how many of these were still alive. A comparison of the figures thus obtained (see table on page 17) clearly shows that the increase of the population in the coastal region was much greater than inland. In my opinion the cause of this difference must largely be sought in the fact that malaria along the coast is not nearly so frequent as inland with the result that the average age, and also the fertility, in the former region is higher than in the latter.

6. In conclusion, a few words ought to be said about the **sanitary conditions.**

As remarked above, all houses are built on piles. Most of them have a well of their own or are situated near a stream where the people can wash themselves properly. Soap is not unknown, nor are latrines, at least to the adults, who do not defaecate wherever it is convenient.

Taking all in all and **considering the standard of education, the state of health of the population of the coastal region may be called reasonable.**

B. Inland: Matan Hulu.

a) The kampongs included in this examination may be classified into the following groups:

1) In the sub-district Marau: (Marau), Pessangeran, Batu Keling, Sedawak, Singkuang, (Silat), Terusan, Pering Kunjit, Pendengeran.
2) Also in the sub-district Marau: Riam Kusik, Penjiruan.
3) In the sub-district Tumbang Titi: Tandjung Djelei, Air Dua, Pengrawan, (Riam Danau), Pangkelan Pakit, Kekura.
4) In the sub-district Sandai: Randau, Entinap, Semapau Hulu, Kepari, Tandjung Beringin, Selangkut.

The arrangement into the groups given above was made according to the location from South to North and corresponds with the number of tours made.

The kampongs in brackets are Malay kampongs.

b) **Population.** The population (except of course in the Malay kampongs) is Dyak.

Leaving aside the group of Catholics, the Dyaks have no religion. At present, agriculture is their main source of living although they are still excellent hunters. Formerly they must have been a nomadic people.

The Dyak of this region considers his kampong as a place of retreat where he only returns, when there is not much work to be done in the ricefields, or on festive or important occasions. They live mainly on the ladangs where they have their (temporary) abodes.

c) The **economy** is very simple. Not so long ago the Dyaks must have been completely autarchic, which to some extent, they still are to-day.

They grow their own rice and the majority of the population has plenty of food provided they do not sell too much of it, which is not an exception. However, the private rice sale in the district of Ketapang is not such as to endanger the general food supply.
Pork is another staple food; every Dyak keeps some pigs and hens. In addition they shoot wild animals, especially swine and deer.
Edible leaves are found in the woods so that there is no shortage of either animal or vegetable proteins.
Wealth and poverty are unknown; the prosperity of a person is measured not so much in terms of money — which has come into use only recently — but in the number of earthen jugs (tempajang) he possesses.
The Dyak has not the slightest aptitude for trade; if he needs something he sells as much rice as necessary to pay for the article wanted. Medicine is often paid for in kind. Some forest products that are welcome addition to the income are: rubber, damar, rattan, belian (iron wood) and tengkawang.

d) **Kampongs.** Long-houses are no longer found in Matan Hulu, except in a section of the northernmost sub-district Sandai. In the architecture of their well-planned houses — on high piles and constructed of iron wood with excellent roofing — the Dyaks have preserved some of their original culture.
On the whole the kampongs are clean, which also applies to the Dyaks themselves.
Life in the kampongs is governed by customary law (a d a t), which differs more or less from one region to the other. The people are held together by a fairly close bond of solidarity which is maintained by a number of noble families who, however, only distinguish themselves from the other villagers by their authority.

e) **Soil.** The land is hilly and is traversed by many rivers and streams. The soil in the larger part of Matan Hulu consists of loam and latrite with a thain layer of humus. The ladangs are laid out on the slopes of the hills (dry rice fields) and in the valleys (rice fields with natural irrigation). This method has the advantage that even if the rainfall has been insufficient the crop will not be a complete failure.

f) **State of health.**

1. In contrast with the coastal region the inland has a high prevalence of malaria. The figures for Matan Hulu are given in table 3.

2. **Ankylostomata** are very prevalent. In the southernmost part of Matan Hulu ankylostomata were found in 52 out of 114 faeces of the Dyaks (45.5%); in a similar examination of 45 faeces of the Malayans ankylostomes were discovered in only 15 cases (33.3%). In the northern part of Matan Hulu ankylostomata were found in 87% of the 325 faeces examined.
It is remarkable that malaria and hookworm cachexia are extremely rare among the Dyaks of Matan Hulu, whereas one or several cases are found in every Malayan kampong in this area.
This difference is possibly due to the fact that acute diseases, such as

TABLE 3

Splenic and parasite indices for Matan Hulu

	Sub-districts		
	Marau	Tumbang Titi	Sandai
Number of persons examined	4770	2042	3241
Number of splenic enlargements	2237	963	1632
Splenic index	47.0	47.2	50.0
Highest splenic index	60.8	54.0	85.2
Lowest splenic index	40.6	35.5	28.6
Number of thick drops tested	4717	2087	892
Number of positive thick drops	756	277	107
Parasite index	16.0	13.3	12.2
Highest parasite index	29.3	17.5	21.2
Lowest parasite index	6.8	11.4	6.2

malaria, pneumonia, children's diseases, among the Dyak children, very often take a fatal course, not in the last place owing to a very poor treatment (bathing in cold water to abate the fever.....). This involves that a selection takes place at a very youthful age and a survival of the fittest.

In contrast with the Dyak section of the inland population, the Malayans are fed most insufficiently; not only because their Islamitic religion forbids them to eat pork but also because their farming is of a very low standard. Whenever possible, they give up their work in the field and turn to trading, with the consequence that sortage of rice is by no means an exeption.

It is probable that also among the Malayans a selection takes place at a very young age. The state of nutrition of Malayan adolescents and adults is so unsatisfactory that malaria and ankylostomiasis get much more chance to affect their state of health than that of the Dyaks. This may account for the fact that although ankylostomiasis is much more prevalent among the Dyaks, wellfed Dyaks are rarely found to suffer from hookworm cachexia and the Malayans frequently.

3. Haemoglobin content. The Hb-content was determined in 2235 blood samples of the inland population. All the persons examined, with the exception of the inhabitants (129) of one (Malayan) kampong, were Dyaks.

This Hb-contents are listed in table 4. In the last two columns of the table the average Hb-contents and the percentages with a Hb-content of 60 or less Malayans are given in brackets.

The haemoglobin contents of the various age groups, with the exception of the youngest, may be called satisfactory. The table shows that there is a large difference between the figures for the inhabitants of the Malayan kampongs and the other persons examined.

TABLE 4

	Persons examined	Haemoglobin content						Average Hb-content	Percentage with Hb-content 60 and lower
		90	80	70	60	50	40		
Men of 19 and older	857	171 20.0%	376 43.8%	238 27.7%	62 7.3%	7 0.8%	3 0.4%	77.4 (72.4)	8.4 (12.1)
Women of 19 and older	688	71 10.3%	331 48.1%	201 29.2%	71 10.3%	10 1.5%	4 0.6%	75.3 (71.1)	12.3 (24.1)
Men from 11—18	198	28 14.1%	83 41.9%	60 30.3%	25 12.6%	2 1.1%	— —	75.5 (70.0)	13.6 (28.5)
Women from 11—18	100	7 7.0%	41 41.0%	37 37.0%	11 11.0%	2 2.0%	2 2.0%	73.4 (64.0)	15.0 (60.0)
Children from 3—10	602	12 2.0%	152 25.2%	229 38.0%	170 28.2%	31 5.2%	8 1.4%	68.7 (62.4)	34.7 (68.3)
Children from 0—2	90	— —	12 13.3%	35 38.9%	30 33.3%	8 8.9%	5 5.6%	64.6 (57.2)	46.6 (57.2)

The haemoglobin contents, measured in 2235 people of the inland region.

4. In addition to what has been said above about the **state of nutrition** I wish to state that in the Dyak kampongs I did not meet with a single case of hunger oedema or xerophthalmia and that serious malnutrition among children was very rare. The state of nutrition of the Dyaks in this region may be called excellent in contrast with that of the Malayans, which was quite unsatisfactory.

5. **Increase in population.** See also page 17.

TABLE 5

	Coastal kampongs	Inland kampongs	
		Dyak	Malayan
Number of inhabitants	6678	3535	1950
Number examined	5017	2958	1048
Attendance (%)	77.3	83.6	54.0
Number of women interviewed	1094	757	259
Number of deliveries	4806	2475	1007
Average number of deliveries per woman	4.4	3.2	3.9
Number of children still alive	3868	1663	690
Average number of living children per woman	3.5	2.2	2.7
Number of dead children	938	812	317
Average number of dead children per woman	0.9	1.1	1.2
Ratio between the number of deliveries and the number of dead children	4.9	3.0	3.2

The above figures show that there is a striking difference in the growth of the population along the coast and inland.

6 **Sanitary conditions in the Dyak kampongs.** Considering the standard of education of the people I am of the opinion that the sanitary conditions in the Dyak kampongs were reasonable. As there is plenty of water, the people are in the opportunity of washing themselves regularly, although it must be remarked that soap is luxury.
Everybody, except of course the very young, always defaecated in the rivers.

In view of the standard of education, the state of health in Matan Hulu, and especially that of the Dyaks, must be called very good.

The differences on this point between coastal region and inland may be summarized as follows:

a) in the coastal region little malaria — inland, endemic malaria;

b) in the coastal region a rapid increase in population — inland the corresponding figures are much lower;

c) in the coastal region the state of nutrition is satisfactory although there is a shortage of vegetable and animal proteins — inland the situation is excellent, except among the Malayans;

d) the haemoglobin content in both regions may be called favourable. It must be stated, however, that inland the haemoglobin content of the Malayans was considerably lower than that of the Dyaks;

e) in view of the standard of education, the housing and sanitary conditions in the two regions are reasonable.

Syphilis. Syphilis does not occur in the district of Ketapang. During the four years that I have worked in this area I met with only one luetic primary affect which, however, was due to an infection contracted outside the district.

In the hospital at Ketapang we made a systematic serological examination of the blood of newly-born children for several years by the M.K. reaction; a distinct positive reaction due to syphilis of the mother was never observed.

CHAPTER II

DESCRIPTION OF THE YAWS ENDEMICS IN COASTAL AND INLAND REGIONS.

The data presented in this chapter have been taken from reports on the systematic anti-yaws campaign conducted in the district of Ketapang.
All diagnoses were made by one the same nurse, who proved himself very dependable and suited for the job. The combat against yaws was commenced after I had examined the majority of the kampongs. During the campaign I kept a regular check on the work done.

Nomenclature.

As regards the names to be used for the various yaws lesions no agreement has been reached as yet.
Many investigators adhere to the well-known classification into stages as is still used in the study of syphilis. This classification is advocated by C. J. Hackett (1953) who, in his publications, has paid much attention to bone lesions in yaws patients. In practice these lesions may indeed be distinguished into secondary and tertiary effects. Palmar and plantar lesions on the other hand can hardly me classified according to this system.
Although the occurence of secondary and tertiary plantar and palmar lesions cannot be doubted, it is often extremely difficult to determine the group in which a given case should be classified.
The distinction into stages is based on a pathological-anatomical difference: proliferative (primary and secondary) and destructive (tertiary). In field research work it has been impossible for me to adhere consistently to this classification. R. D. Harding (1949) experienced the same difficulty in describing the yaws endemic in Sierra Leone.
A bulletin issued by the World Health Organization (1952) gives eight classification systems; six of these are purely descriptive, summarizing the various lesions observed in the course of the disease. One system is based on the customary classification into stages.
Teertman (Haiti) distinguishes the lesions into „Infectious and non-infectious lesions". This system, which agrees to that suggested by Harding and also to the one chosen by me, does not give rise to serious difficulties in practice.
The nomenclature used in this study is as follows:

Infectious lesions:	1) mother yaw and polypapillomatosis 2) localized papilloma (crab yaw);
Non-infectious lesions:	3) palmar and/or plantar lesions; 4) other lesions.

sub 1) The „mother yaw", also known as the „primary affect" is not mentioned separately. In many cases it is extremely difficult to establish whether or not we are concerned with a mother yaw. Many primary

affects, particularly in coastal region, originate from ulcerations. The number of typical primary affects is so small as to be negligible compared with the high prevalence of polypapillomatosis.

sub 2) In English literature the localized papilloma is referred to as „foot yaws" or „crab yaw". It must be stated that this term is somewhat misleading because the papilloma need not necessarily be localized on the soles of the feet or the palms of the hands. It may also occur, althought not frequently, on other parts of the body (knees, elbows).
Of course, palmar and plantar papillomata occur in conjunction with the generalized form. The localized papilloma however, does not appear until after the stage of papillomatosis. For these two reasons, that is to say its localization and its appearance after other infectious manifestations, I am of the opinion that the localized papilloma should be distinguished from the generalized stage.

sub 3) Palmar and/or plantar lesions. This group includes all the lesions on the palms of the hands and the soles of the feet caused by yaws (with the exception of the papilloma). So not only the later manifestations (keratodermia) come under this heading, but also the very early erythemato-squamous lesions as are especially seen in children during and after polypapillomatosis.
The appearance of palmar and plantar lesions varies so much that a closer specification cannot be given here.

G. Baermann (1908), in his excellent article on „Die spezifische Veränderungen der Haut und Füze bei Frambösie" says: „Die Erscheinungen sind so polymorphe und ihren einzelnen Verlaufsphasen so different, dasz durch die Beschreibung allein das Krankheitsbild nicht eschöpft werden kann".

M. J. G. Furnell (1943) gives a description of plantar lesions in negroes that cannot be ascribed to yaws. Cracked soles; superficial fissures that are not painful; keratitis punctata; small superficial pits in the leathery epidermis of the sole of the foot; verrucae plantaris.

D. B. Jelliffe and J. Humpheryes (1952) give a similar description. According to the latter two publications great care should be excercised in ascribing the plantar lesions to yaws.
The affections described by these authors, which are also very prevalent in the district of Ketapang, are to be considered as non-specific skin lesions of traumatic origin on the sole of the foot.
A conclusive method for the diagnosis of doubtful cases is by palpation. If the plantar lesion is due to yaws, the entire epidesmis is hard and leathery. This criterion is so simple that after some experience the diagnosis can be made without looking. Palpation should preferably be made in the hollow of the sole. If the characteristic leatheriness mentioned above is not observed here, there is every reason to doubt whether the affection is due to yaws.
When the patient has been treated for yaws, the abnormal figuration of the skin surface may persist for several months; the typical hardness

and leatheriness of the skin, however, disappear rapidly.
Using the above criterion I also found that the affections described in the two previous publications are not associated with yaws.

The nomenclature chosen for the following part of this thesis does not pretend to be a standard classification of yaws lesions. Its motivation, however, is based on the following points:

1) It is adapted to the practice of field research work;

2) Is it directed to the problems dealt with in this thesis;

3) The first three manifestations include 87—91 per cent of all yaws lesions;

4) The other lesions mainly consist of „ulcerations".

In many cases, the diagnosis „yaws ulcus" cannot be made with certainty.
Compared with the prevalence of papillomatosis and palmar and/or plantar lesions, the remaining lesions are so small in number as to be unimportant for the first part of this study.
Later, however, (Ch. VI) when it is attempted to give a further specification of the endemics, they will have to be considered more closely.

Persons with more than one type of lesion have been classified as suffering from the lesion indicated by the lowest number.
For the lowest age group, where plantar lesions often occur in combination with papillomatosis, this consequently gives rise to an incorrect picture of the prevalence of the former. However, this is not a drawback here because the prevalence of plantar lesions in children has been left out of consideration.

All recorded cases were treated twice with 4 cc. of procaine penicillin + 2 per cent of aluminum monostearate (PAM) and re-examined after periods varying from three to six months.
The correctness of the diagnosis, therefore, was confirmed ex juvantibus.

TABLE 6

Age distribution of the population in the coastal region.

Age:	0—2	3—10	11—18	19 and older	Total
Peasaguan Kanan	145	394	133	628	1300
Pesaguan Kiri	71	365	153	502	1091
Sungei Besar	117	393	249	564	1323
Sungei Pelang	46	243	126	355	770
Sungei Djawi	75	298	151	513	1037
Total	454	1693	812	2562	5521

TABLE 7

Age distribution of the population in the inland region.

Age:	0—2	3—10	11—18	19 and older	Total
Riam Danau	49	193	65	344	651
Air Dua	20	73	38	214	345
Tandjung Djelei	48	191	86	377	702
Pengrawan	5	31	24	73	133
Pangkelan Pakit	21	41	29	96	187
Kekura	26	62	25	129	242
Total	169	591	267	1233	2260

TABLE 8

Attendance in the coastal region.

Age:	0—2	3—10	11—13	19 and older	Total
Pesaguan Kanan	122	338	98	440	998
Pesaguan Kiri	56	249	108	377	790
Sungei Besar	91	310	173	375	949
Sungei Pelang	33	175	85	199	492
Sungei Djawi	53	234	104	346	737
Total	355	1306	568	1737	3966

TABLE 9

Attendance inland.

Age:	0—2	3—10	11—13	19 and older	Total
Riam Danau	44	175	54	284	557
Air Dua	18	68	36	197	319
Tandjung Djelei	40	151	69	286	546
Pengrawan	5	30	23	68	126
Pangkelan Pakit	21	39	26	92	178
Kekura	26	62	23	122	233
Total	154	525	231	1049	1959

TABLE 10

Attendance as a percentage of the total number of people per age group.

Age:	0—2	3—10	11—18	19 and older	Total
A. Coastal region	78.2	77.0	68.8	67.8	72.6
B. Inland	91.0	88.8	86.5	84.9	86.7

The percentage attendance was lowest in the coastal region.
Strictly speaking, the number of persons examined here was not large enough to permit an estimation to be made of the true prevalence of

yaws. However, since this study is aimed mainly at comparing the frequencies of the various manifestations of yaws and not at determining the total number of yaws cases, the attendance may be considered sufficient. To this it must be added that those who had been absent at the first examination but turned up at the first follow-up, showed a considerably lower percentage of yaws cases than the people that had been examined first. Nevertheless, the percentage incidence of yaws cases given below is somewhat high, that is to say at least for the coastal region.

DISTRIBUTION OF THE LESIONS OVER THE VARIOUS AGE GROUPS.

1. Polypapillomatosis and „Mother Yaw".

TABLE 11

Coastal region.

Age:	0—2	3—10	11—18	19 and older	Total
Pesaguan Kanan	13	36	0	1	50
Pesanguan Kiri	4	43	3	2	52
Sungei Besar	7	67	2	0	76
Sungei Pelang	1	18	3	1	23
Sungei Djawi	2	28	2	0	32
Total	27	192	10	4	233

TABLE 12

Inland.

Age:	0—2	3—10	11—18	19 and older	Total
Riam Danau	0	7	3	4	14
Air Dua	0	3	2	0	5
Tandjung Djelei	0	4	2	0	6
Pengrawan	0	1	0	0	1
Pangkelan Pakit	0	1	0	0	1
Kekura	0	3	0	1	4
Total	0	19	7	5	31

TABLE 13

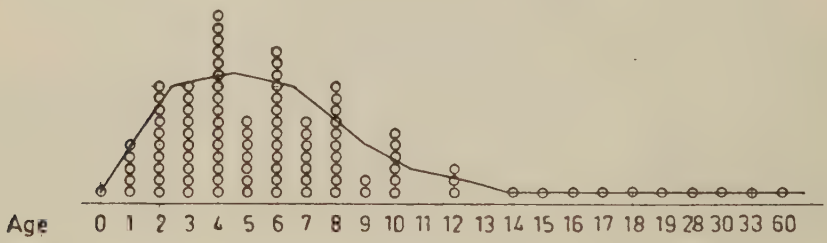
Incidence of papillomatosis expressed as a percentage of the number of people examined in every age group.

Age:	0—2	3—10	11—18	19 and older	Total
A. Coastal region	7.6	14.7	1.8	0.2	5.8
B. Inland	—	3.6	3.0	0.5	1.6

1) The incidence of papillomatosis in the coastal region must be called high where as inland it is remarkably low.

2) The variation in the percentages given for the various age groups (cf. Graphs II and III, page 29) suggests that the majority of the people are infected below the age of ten.
To check this, 375 school-children in the coastal region were examined; 275 of them showed active yaws lesions or scars of healed papillomata. Most papillomata leave a scar on healing which becomes less distinct in the course of time but can be very easily recognized in children. From this examination it appears that at least 87 per cent of the school-going childeren were infected.

3) In the coastal region the incidence was highest among two to six-year olds, as can be seen in the following graph.



GRAPH I

One hundred cases of papillomatosis in the coastal region arranged according to the age of the patients.

Every circlet represents one case of yaws.
As I seem to have had a distinct aversion to estimating the age at an odd number of years, I have plotted the curve through the points obtained by averaging the numbers of cases found in two and three, four and five year-olds and so on.

4) Inland, the incidence of papillomatosis presents and entirely different picture. The percentage of school-children with scars was much lower thans in the coastal region. Of 87 children examined no more thans 29 showed characteristic scars resulting from yaws lesions (24.2%); in the kampongs Riam Kusik and Pejiruan scars were found on only 17 out 88 children varying in age between 3 and 10 (19.3%). It is altogether out of the question therefore that a high percentage of the children should be infected below the age of ten, as was the case in the coastal region.
The small number of cases makes it impossible to make a trustworthy estimate of the age at which the lesion is particularly likely to occur. A comparison between the figures given for the inland and coastal regions (vide graphs II and III, page 29) shows that inland the majority of cases of papillomatosis are observed at a distinctly higher age than in the coastal region.

2. Localized papilloma.

TABLE 14

Coastal region.

Age:	0—2	3—10	11—18	19 and older	Total
Pesaguan Kanan	0	14	3	6	23
Pesaguan Kiri	0	21	12	10	43
Sungei Besar	0	20	7	15	42
Sungei Pelang	0	11	4	8	23
Sungei Djawi	0	16	7	9	32
Total	0	82	33	48	163

TABLE 15

Inland.

Age:	0—2	3—10	11—18	19 and older	Total
Riam Danau	0	1	0	3	4
Air Dua	0	2	0	2	4
Tandjung Djelei	0	8	1	1	10
Pengrawan	0	0	3	1	4
Pangkelan Pakit	0	3	2	1	6
Kekura	0	1	0	2	3
Total	0	15	6	10	31

TABLE 16

Incidence of localized papilloma as a percentage of the total number of persons examined per age group.

Age:	0—2	3—10	11—18	19 and older	Total
A. Coastal region	—	6.3	5.8	2.8	4.5
B. Inland	—	2.9	2.6	1.0	1.6

Graphs II and III on page 29 show that the highest incidence of localized papilloma is found among people older than those showing the highest incidence of papillomatosis.

Palmar and/or plantar lesions

(except localized papilloma)

TABLE 17.

Coastal region

Age:	0—2	3—10	11—18	19 and older	Total
Pesaguan Kanan	0	6	5	31	42
Pesaguan Kiri	0	7	6	59	72
Sungei Besar	0	1	3	15	19
Sungei Pelang	1	6	5	16	28
Sungei Djawi	1	5	6	36	48
Total	2	25	25	157	209

TABLE 18.

Inland

Age:	0—2	3—10	11—18	19 and older	Total
Riam Danau	0	10	11	58	79
Air Dua	0	6	10	77	93
Tandjung Djelei	0	13	24	77	114
Pengrawan	0	4	2	21	27
Kekura	0	2	7	38	47
Pangkelan Pakit	0	6	7	35	48
Total	0	41	61	306	408

TABLE 19.

Incidence of palmar and/or plantar lesions as a percentage of the total number of persons examined per age group.

Age:	0—2	3—10	11—18	19 and older	Total
A. Coastal region	0.6	1.9	4.4	9.0	5.8
B. Inland	—	7.8	26.4	29.2	20.8

1) As stated on page 20 the term „plantar and/or palmar lesions" includes not only those affections which sometimes are indicated by the name „keratodermia" but, amongst others, also the early erythemato-squamous lesions. This explains why in table 17 two cases have already been listed in the age group „0—2".

2) Along the coast the incidence of palmar and/or plantar lesions expressed as a percentage of the total number of people examined is about equal to the percentage incidence of papillomatosis. Whether this percentage must be considered as high or low is difficult to say. Taking into consideration, however, that palmar and plantar lesions tend to be persistent, the percentage does not seem high, especially if compared with that of papillomatosis, which is only of a temporary nature.

3) Whereas in the coastal region the percentage incidence of papillomatosis corresponds fairly closely with those of the localized papilloma and the palmar and/or plantar lesions, the inland percentages only show such an agreement for the first two lesions. The percentage of palmar and/or plantar lesions inland was surprisingly high compared with the other two.

TABLE 20

Incidence of the three lesions as a percentage of the total number of people examined.

	Papillomatosis	Localized papilloma	Palmar and/or plantar lesions
A. Coastal region	5.8	4.5	5.2
B. Inland	1.6	1.6	20.8

The high percentage of papillomatosis in the coastal region compared with the low percentage inland on the one hand, and the low percen-

tage of palmar and/or plantar lesions in the coastal region compared with the high percentage inland on the other, constitutes the problem which will be dealt with this thesis.

To obtain a better idea of the ratios between the frequencies of the various yaws lesions I have thought it advisable to give the numbers of cases as a percentage of the total number of yaws lesions observed.

Total number of yaws lesions

TABLE 21.

Coastal region.

Age:	0—2	3—10	11—18	19 and older	Total
Pesaguan Kanan	13	63	14	45	135
Pesaguan Kiri	4	75	23	78	180
Sungei Besar	7	102	16	34	159
Sungei Pelang	1	42	15	30	88
Sungei Djawi	4	61	17	54	136
Total	29	343	85	241	698

TABLE 22.

Inland

Age:	0—2	3—10	11—18	19 and older	Total
Riam Danau	0	18	15	73	108
Air Dua	0	13	15	89	117
Tandjung Djelei	0	27	31	86	144
Pengrawan	0	6	5	24	35
Pangkelan Pakit	1	10	10	41	62
Kekura	0	6	8	43	57
Total	1	80	84	356	523

Incidence of the lesions as a percentage of the total number of yaws cases.

TABLE 23.

Coastal region.

Age:	0—2	3—10	11—18	19 and older	Total
1. Papillomatosis and mother yaw	3.9	27.5	1.4	0.6	33.4
2. Localized papilloma	—	11.7	4.7	7.0	23.4
3. Palmar and/or plantar lesions	0.3	3.6	3.6	22.4	29.9
4. Other lesions	0.1	6.3	2.5	4.4	13.3
Total	4.3	49.1	12.2	34.4	100.0

TABLE 24.

Inland.

Age:	0—2	3—10	11—18	19 and older	Total
1. Papillomatosis and mother yaw	—	3.6	1.3	1.0	5.9
2. Localized papilloma	—	2.9	1.1	1.9	5.9
3. Palmar and/or plantar lesions	—	7.9	11.7	58.7	78.3
4. Other lesions	—	1.1	2.1	6.7	9.9
Total	—	15.5	16.2	68.3	100.0

A survey of the incidence of lesions expressed as a percentage of the number of people examined per age group and of the total number of cases found is shown in the graphs II and III (page 29).

With regard to the „other lesions" we may be brief. The lesions mentioned so far account for 86.7 % of the cases found in the coastal region and for 90.1% of those observed inland.

What has been said in these two chapters may be considered sufficient for a general review. Later it will be seen, however, that a discussion of the „other lesions" is of great importance for obtaining a proper understanding of the nature of the endemics. The data given so far have been collected in the combat against yaws. The methods for the diagnosis of the other lesions are so complicated and laborious that the results obtained by them in a large-scale campaign cannot be trusted.

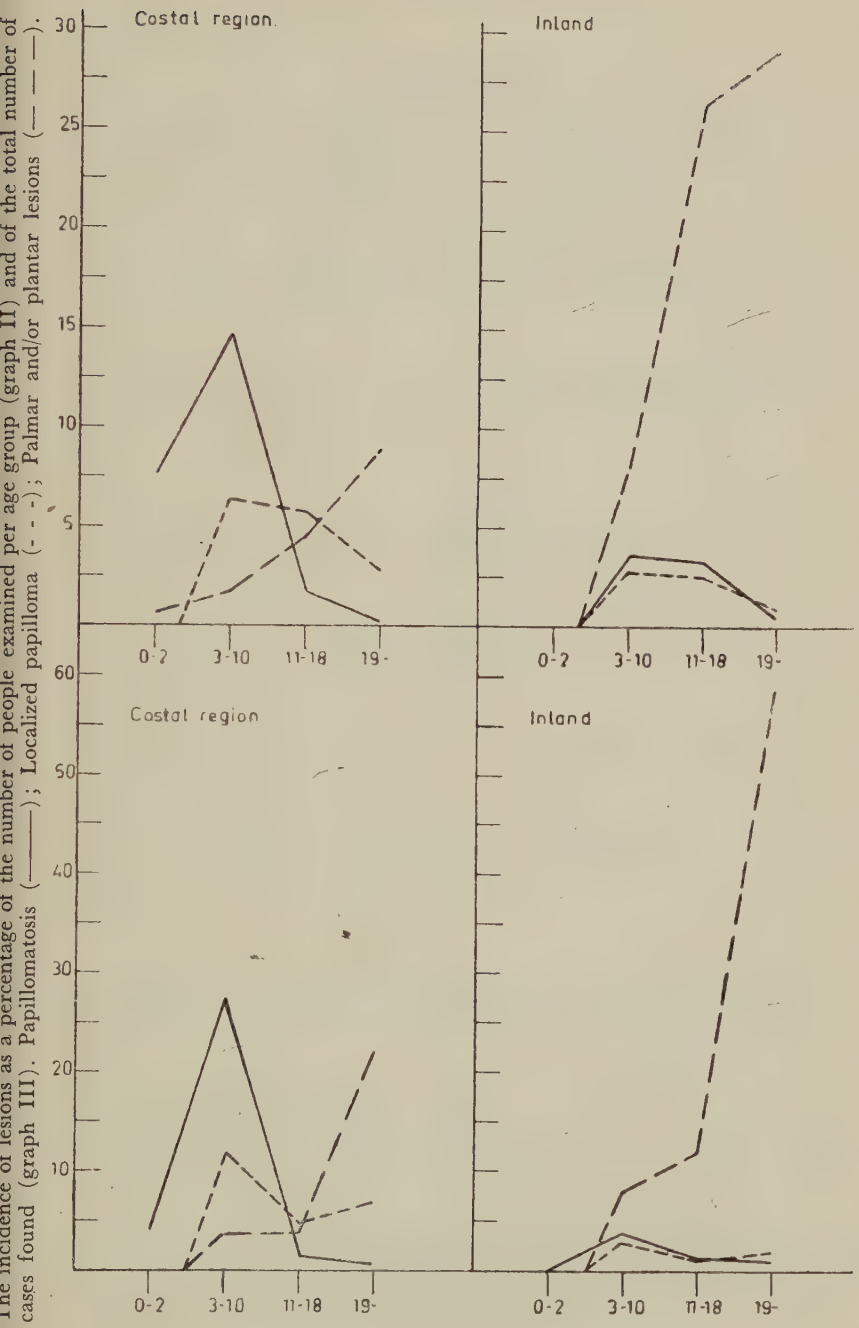
For the sake of completeness a further specification of the „other lesions" is given below; it must be stated, however, that the number of cases of nodosity is certainly much too low because this type of lesions may be easily overlooked.

TABLE 25

	Coastal region	Inland
Nodosity	3	5
Periostitis	22	15
Ulcerations	55	
Other lesions	13	32
Total	93	52

These lesions, therefore, constitute 13.3% and 9.9% of the total number of yaws cases found in each of the two regions.

GRAPH II



The incidence of lesions as a percentage of the number of people examined per age group (graph II) and of the total number of cases found (graph III). Papillomatosis (———); Localized papilloma (- - -); Palmar and/or plantar lesions (— — —).

GRAPH III

CHAPTER III

HOW CAN THE DIFFERENCE IN THE RELATIVE FREQUENCY OF POLYPAPILLOMATOSIS BETWEEN COASTAL REGION AND INLAND BE EXPLAINED?

As shown in Tables 23 and 24 (Ch. II, page 27) the inland has a much lower percentage incidence of polypapillomatosis than the coastal region. To what causes must this difference be ascribed?

Coastal region

1. Is there any ground for presuming that the yaws endemic is becoming more prevalent?

Was the endemic a few years ago of less significance than it is now and must the present high percentage of contagious forms be ascribed to an "accidental" explosive outburst?

a) For the coast no exact data are available about the incidence of yaws in the past. However, the figures given in the previous chapter show that of the total number of people suffering from polypapillomatosis (233), 219 were younger than ten.
It seems most unlikely that a similar distribution would have been found if the endemic had not been equally prevalent in the past.
Furthermore it is logical to conclude that if an endemic takes a favourable or unfavourable turn, there must have been some causes by which such a change can be explained.

b) The principal factor that may particularly affect the epidemiology of the disease is an improvement or worsening of the social and economic situation. Neither the one nor the other has occurred.
One might only say that since the war conditions have been restored to prewar level. This contradicts the supposition that the endemic should be on the rise.
The conclusion therefore is that the high incidence of polypapillomatosis in the coastal region cannot be explained by a change in the social and economic conditions.

c) Another factor that has to considered in explaining the high prevalence of yaws along the coast is the way in which the patients were treated in the past. Up to the end of 1949 the kampongs Pesaguan Kanan and Sungei Besar were visited about three times a year. The doses of salversan administered were small (300 mg) and no patient was given more than one injection.
In the period January 1950—April 1952 treatment on the spot was suspended. Patients who wanted an injection could apply to the polyclinic at Ketapang (12—28 km. from the kampongs), but only very few made use of this opportunity.

I believe that neither the treatment of the patients in the past, nor the interruption of the treatment, has contribued to the present high prevalence of polypapillomatosis.

d) It is believed that the difference in climatological conditions between the dry and the wet season is reflected in a difference in the frequencies of infectious yaws lesions. Later this will be discussed in more detail.
In the district of Ketapang, however, there is only a gradual difference in rainfall between the two seasons. A dry period in the true sense of the word does not exist, the district being located at about 1°30'S. latitude. In addition it must be stated that the examinations in both areas were made in the wet season: the coastal region in March 1952; the inland in December 1952.
From what has been said above it appears that the figures reported in the previous chapter may indeed be considered to give a representative picture of the endemic in the coastal region.

Inland.

2. Is there any ground for presuming that the endemic is changing and, more particularly, that the endemic is on the decline?

Should the endemic have been very prevalent in the past there would be many old people showing late forms. In case of a sharp decrease in recent years, few (early) lesions would be found in the younger age groups.

a) The high incidence of yaws inland is mainly due to the large number of palmar and/or plantar lesions, not only in adults but also in children from 3 to 10.
This appears very clearly from a comparison between the frequencies of the various lesions found among children from 3 to 10 in the two regions.

TABLE 26

Numbers of the various lesions in 3-10 year olds as a percentage of the total number of yaws cases in this age group.

	Coastal region	Inland
1. Polypapillomatosis	53.1	23,7
2. Localized papilloma	23.9	18.7
3. Palmar and/or plantar lesions	7.3	51.4

As stated in the discussion of the nomenclature used (page), persons suffering both from an infectious and a non-infectious lesion have been classified under the infectious one. Hence it is obvious that the number of palmar and/or plantar lesions reported for children from 3 to 10 in the coastal region is considerably below the actual figure.

b) Have the social and economic conditions changed to such a degree that the endemic is on the decline now?
There is nothing to show that this has indeed been the case. On the contrary, the appearance of the kampongs suggests that the hygienic conditions have worsened rather than improved. Also the economic situation has remained virtually the same. The population is still leading a most primitive life.

c) The treatment has not had the slightest effect on the endemic in this area; the nearest policlinic is at least 36 km away.

d) Just as in the coastal region the effect of the climate may be neglected.

e) The number of people examined is relatively small. Nevertheless the picture deduced from the figures for the inland region is not an accidental one as will appear from the data given below. These were collected on a tour through an adjoining district south of the territory to which the above tables refer.
The total number of persons examined need not be given here because the attendance figure is not representative of the number of people living in the district. It may suffice therefore to mention only the numbers of cases of the various yaws lesions:

TABLE 27a

Age:	0—2	3—10	11—18	19 and older	Total
1. All infectious forms including the localized papilloma	6	41	13	16	76
2. Palmar and/or plantar lesions	1	70	106	625	802
3. All other lesions	—	4	6	27	37
Total	7	115	125	668	915

and the incidence of the various lesions as a percentage of the total number of yaws lesions:

TABLE 27b

Age:	0—2	3—10	11—18	19 and older	Total
1. All infectious forms including the localized papilloma	0.7	4.5	1.4	1.7	8.3
2. Palmar and/or plantar lesions	0.1	7.7	11.6	68.3	87.7
3. All other lesions	—	0.4	0.7	2.9	4.0
Total	0.8	12.6	13.7	72.9	100.0

The examination was carried out in the kampongs:
Riam Kusik, Marau, Pessangeran, Batu Belian, Batu Keling, Singkuang, Silat, Terusan, Pendengeran, Kemuning, Klampai and Pering Kunjit.
The above tables show that the picture of the endemic described in Chapter II does not bear an accidental character.
That such a high percentage of palmar and/or plantar lesions is not uncommon also appears from a publication by H a r d i n g R.D. (1949), who states that 70% of the total number of yaws cases found in Sierra Leone are palmar and plantar lesions, varied from 40 to 90%.
G u t i e r r e z P. D. (1925) reports that of 973 yaws patients examined 74% showed palmar and/or plantar lesions.
The only question that has to be answered now is: *how can it be explained that the percentage incidence of polypapillomatosis inland is much lower than in the coastal region?*

3. Must the difference in the incidence of polypapillomatosis be ascribed to a difference in the percentage of people infected?

As shown in Table 20 polypapillomatosis was found in 5.8% of the number of people examined at the coast, the corresponding figure for the inland being 1.6%. Even if the whole coastal population should have been infected, it follows from a simple calculation that the percentage of people infected in the inland region cannot be higher than 1.6/5.8 x 100 = 27.5%. As 24% of the examined inland population had been found to suffer from yaws lesions, the percentage calculated above would suggest that inland the number of latent cases and spontaneous recoveries is very low. In view of this calculation it must be considered most unlikely that the difference in the incidence of polypapillomatosis between coastal region and inland can be accounted for by a difference in the percentage of infected people **alone.** In practice this would imply that no spontaneous recoveries nor latent cases occur inland.
It is true that the existence of a difference in the numbers of latent cases and spontaneous recoveries between the two regions ought to have been proved by a serological examination. However, under the conditions prevailing in the district of Ketapang it was technically impossible to make such an examination in the proper way.
Nevertheless, the possibility of a difference between the two regions as regards the numbers of infected people and the numbers of latent cases and spontaneous recoveries should be reckoned with.

4. An entirely different possibility which is not contradictory to the existence of a normal percentage of latent cases and spontaneous recoveries inland is **that the stage of polypapillomatosis inland has a shorter duration than at the coast.**
It has been tried to investigate this point using the literature together with data taken from our own experience.

CHAPTER IV.

WHAT FACTORS MAY HAVE AN EFFECT ON THE DURATION OF PAPILLOMATOSIS?

Whereas the problem propounded at the beginning of the previous chapter can, in fact, not be solved unless all epidemiological aspects of yaws are taken into consideration, the above question may be answered by using only those epidemiological data as may have an effect on the duration of papillomatosis.

Every epidemiological study can be distinguished into three parts, dealing with:

A. the virus;
B. the mode of transmission;
C. the new host;

A. The treponema pertenue.

If the difference in the duration of papillomatosis between coastal region and inland should have to be ascribed to the character of the treponema pertenue, it is an obvious conclusion that there must exist differences between the strains of treponemes themselves. It is a well known fact that the characteristics of every virus are subject to variations: its virulence tends to fluctuate. Consequently this must also be true then for the treponema pertenue.

In view of a comparative study on the yaws endemics in Panama and Haiti, P. W. Wilson (1934) concludes that the treponema strain in Panama is less virulent than that in Haiti.

G. W. Harley (1933) believes that the treponema pertenue may be distinguished into several strains and that this difference may, among other things, be responsible for the existence of different yaws endemics. Some examinations in this field that have to be noted here were carried out by T. B. Turner, D. H. Hollander and K. Schaeffer (1953) of the „International Treponematosis Laboratory" in Baltimore, who are engaged on inoculation experiments with treponema strains received from various parts of the world.

T. Guthe and R. R. Willcox (1954), referring to the above examination, state: „It has been observed that there are persistent differences between and within established types and strains of treponemes. It appears that these differences are quantitative rather than qualitative and it is believed that the characteristics of a particular strain are based primarily on its capacity to produce hyaluronic acid".

A point of importance for this study is that the existence of **different strains of the treponema pertenue** has to be reckoned with. Whether such af difference actually exists in the district of Ketapang, and whether this difference might partly account for the difference in duration of papillomatosis between coastal region and inland, is a

question that cannot be answered within the framework of field research.

Numerous inoculation and reinoculation experiments have been made with the treponema pertenue. Thomson (1819) already carried out inoculation tests with the „morbid poison called yaws".

P. Paulet (1872) inoculated 15 yaws patients with virus from their own bodies without this having any effect; when the same material was inoculated into people that had not been afflicted with yaws, new lesions did appear.

M. Charlouis (1881) and A. Powell (1923) obtained indentical results in experiments conducted on a smaller scale.

More extensive investigations were undertaken by A. W. Sellards and E. W. Goodpasture (1923) and by A. W. Sellards, Lacy and O. Schöbl (1926). In 5 out of 6 starting cases of polypapillomatosis reinoculation with heterological material resulted in new lesions. Auto-inoculation of 6 patients suffering from active yaws (duration of the disease: 2 months—1 year) produced a new lesion in only one of them. Four patients who had recovered from papillomatosis six months before (duration of the disease: 4 months—2 years) were reinoculated with heterological material; only two acquired new lesions, the others developing small papillae which the authors describe as „abortive". When two years later the same persons were reinoculated with heterological material, generalized lesions appeared on one, abortive forms on two, while the fourth did not respond at all.

The most extensive examinations in this field were carried out by T. B. Turner (1936).

Auto-inoculation of 18 people (age: 2—11) resulted in a new lesion in only one; this patient suffered from a wide-spread papillomatosis that had started 5 months before.

Turner reinoculated 67 yaws patients (durations of the disease: 1—65 years) with heterological material and found that 49.2% produced new lesions. The positive results appeared to vary with the duration of the disease, that is to say: the longer the duration the lower the percentage of successful reinoculations. Nevertheless, the percentage for cases with a duration varying from 10 to 65 years was still 15.8 %.

The new lesions observed by Turner — papillomata or ulcerative variations thereof — were not generalized (with the exception of a few) and were confined to the reinoculated spot and its immediate surroundings.

The reinoculation experiments discussed above have led to the following conclusions:

1. **Auto-inoculation** is only possible in the very first stage of the disease;
2. **Reinoculation** with heterological material may take place for a very long time;
3. In the event of reinoculation **the new lesion** is usually restricted to the reinoculated spot and its immediate surroundings; a generalized eruption due to reinoculation is an exception.

Strictly speaking, the mere fact that reinoculation may result in new lesions does not justify the conclusion that reinfection actually occurs. In practice, however, one repeadtedly encounters cases which can hardly be due to causes other dan reinfection. Adults who acquired their first yaws infection in childhood may develop an isolated papilloma, usually as a result of direct contact with the papillomata of their children.
It must be noted, however, that only few authors have paid attention to reinfection in yaws patients, and is only mentioned in discussions on the periodicity of the contagious forms of yaws in several areas. Later, this phenomenon will be dealt with in greater detail. A question that may be asked here is whether the periods observed in the course of papillomatosis (with a silent interval of a few months) must be considered as relapses or as a result of reinfection.
C. J. Hackett (1946) says: „It is possible that some of the subsequent eruptions of secondary lesions may be accidental reinfections, however, the degree of infections necessary to produce this as a rule, would rarely be encountered under natural conditions".
In view of the reinoculation experiments described above it must be considered unlikely that reinfections may produce successive generalized eruptions. The significance of reinfection as the cause of a local reaction is not discussed in the literature.

Another point that has to be mentioned here is **the influence of temperature and humidity** on the life and activity of the treponema. It is especially H. D. Chambers who has laid stress on the significance of temperature and humidity for the development of yaws.
In his monograph on yaws (1938) he states: „The chief factors in the distribution of yaws are warm climate and humidity. Any influence which unhygienic conditions may exert, or which flies, such as Hippelates pallipes, may have in the dissemination of the disease can occur only in areas with tropical humid climate. Other factors such as rainfall, geological formation, vegetation, altitude, distance from sea, are of importance only in so far as they affect humidity".
In principle this statement is correct, certainly if Chambers wants to say that a given minimum degree of humidity and heat are conditiones sine qua non, but this does not rule out the possibility that there may exist other factors that have a direct effect on he yaws endemics.
Further, Chambers developes an interesting theory on the significance of the repeatedly relapsing papillomata on the soles of the feet. He states that the treponema pertenue may exist for many years in a latent form in the thick epidermis of the sole of the foot, to become active under favourable conditions — increased humidity of the epidermis — and thus produce crab-yaw.
This agrees with observations by several authors who state that the number of infectious forms increases during the wet season (R. D. Harding (1949); G. M. Findlay (1946); T. Simpson (1938); K. R. Hill (1953); C. J. Hackett (1953)).

It is believed that many inactive treponemes are activated by a rise in humidity of the skin, with the result that the number of external lesions increases. In addition, the higher humidity during the wet season will enable the treponemes to persist for a longer period near the skin surface and thus increase the hazard that non-infected people will acquire an infection.

H a r d i n g, accordingly, ascribes the increase in the number of infectious forms during the wet season to an increase in the number of relapses and to a greater infection hazard for non-infected people.

The significance of temperature and humidity appears particularly from an observation by several investigators who noted that patients from a mountain district often display a violent increase of the eruptions when visiting warm and humid lowland areas. (C. G. R a m s a y (1925); L. L o p e z R i z a h and A. W. S e l l a r d s (1926)). The same workers also report that during the cold season the papillomata tend to retract to the warmer and more humid parts of the body.

No attempt has been made in the literature to find a correlation between the duration of papillomatosis on the one hand and temperature and humidity on the other. However, it is beyond doubt that these two factors highly affect the outward appearance of papillomatosis.

B. **Can the way of transmission have an effect on the duration of papillomatosis?**

Transmission may take place by:

1) **Direct contact.** This mode of dissemination is beyond any doubt, as appears from numerous evident examples.

2) **Indirect contact**, via contaminated articles of use, floors, walls etc. An essential condition, however, is that the treponema can persist outside the body. Only few investigations have been made to establish the period of this extracorporeal existence and the conditions under which it is possible.

K. Y a w u y a m a (1928) has shwon that at —2°C the treponema pertenue remains mobile in a salt solution for half an hour; in serum for two hours.

H. D. C h a m b e r s (1938) noticed that at 29°C the treponema pertenue retained its mobility in serum dorps for 8 hours. The drops had been collected on object glasses and exposed ot the air. The higher the humidity of the atmosphere, the longer the treponemes remained mobile.

As to the possibility of indirect transmission there exists some diversity of opinion.

P. M a n s o n B a h r (1948) very positively states: "Cases originate in certain dirty houses, the virus from previous yaws patients seemingly imprenating the floors and walls of filthy huts. In this manner the disease may be, and in some cases no doubt is, acquired without direct transference from any existing case".

K. R. H i l l (1953), in his observation on the mode of transmission, does not make separate mention of infection by indirect contact and

even goes so far as to call it unlikely: "Furthermore the fact that very few cases (mother yaw) occur on the soles of the feet, rather precludes the possibility of infection from droppings".
This argument, however, is rather weak. True, the mother yaw is found fairly seldom on the soles of the feet, but this may be because the epidermis of the sole is so thick that hardly any skin lesions will occur here; to this it must be added that people who are used to go barefoot, tend to put their feet dwon with extreme care. Lesions on the sole of the foot are usually very serious and lead to disablement.
H. D. Chambers (1938) remarks that the mother yaw on the soles of the feet was by no means infrequent amongst a people who used to walk on rocky ground.
C. J. Hackett (1953), in citing the views of 12 reporters from various parts of Africa, does not mention this possibility in his chapter on "The usual means of transmission", although in the summary he says: „Thus it may be surmised that where these lesions (mother yaw) occur on the buttocks, the infection has come from sitting on the ground".
My own experience fully agrees with Hackett's last statement. In 14 out of 102 cases of mother yaw of which the favourite site could be determined, the affect was found to be localized on the nates and the upper dorsal part of the thighs. All these fourteen were children from 2 to 9 years old. It is unlikely that these cases should have been due to contact infection as the children in this area, although they are used to walk around naked in the daytime, sleep in their clothes.
Indirect contact, therefore, has to be considered a most likely mode of transmission; its frequency naturally depends on factors as clothing, hygiene, living and sleeping habits and, as far as the lifetime of the treponema outside the human body is concerned, on temperature and humidity.

3. Transmission by vectors.

In his article "Yaws and flies" Cyril C. Barnard (1952) gives a complete review of the literature on this subject. Of the 154 citations given, 86 refer to original observations and experiments by the authors mentioned. In 49 citations the flies have been specified (of the Chloropidae or of the Musca genus). 12 authors consider flies as important, some even as very important factors in transmitting the treponema. A world-wide inquiry has furnished only little new information on the point. In his conclusion Barnard says:
".....the general conclusion is clear. It may be expressed thus: various species of flies can and do act as mechanical vectors of yaws in most parts of the tropics, but the extent to which this is an important or even common mode of dissemination is uncertain and probably varies in different localities. The principal vector in the western hemisphere is Hippelates flavipes, that in India and Malaya Siphunculina funicola, and that in Africa, Asia and Australia generally the housefly or other species of Muscidae".

A. Castellani (1907), J. G. Thomson and W. A. Lamborn (1934) found the treponema pertenue in the Musca domestica and in a "non-biting haematophagous fly". Unfortunately the procedure used for bringing the flies into contact with the treponemes was not a physiological one.

A. Robertson (1908) caught 200 flies on yaws lesions, washed them out in sterile water and noticed living treponemes in laboratory samples prepared of the centrifagate. Unfortunately he does not give a specification of the flies used.

The most important investigations in this matter were carried out by H. W. Kumm and coworkers (1935 a, b, c), who collected 673 flies of the Hippelates flavipes on one yaws lesion within 15 minutes and found 304 living treponemes in the flies after 1 minute, 138 after 6 hours and 15 after 18 hours. The treponemes appeared to remain mobile for 7—8 hours in a diverticulum of the esophagus. After being regurgitated they were still capable of transmitting the disease to rabbits.

Kumm concludes the description of this very critically conducted examinations with the following statement: "The foregoing experiments demonstrate that yaws can be transmitted from man to rabbits by H. pallipes (identical to H. flavipes) and that there is every reason to believe that this is also true for man to man transfer".

The above authors also point out that the distribution of yaws in Jamaica shows a remarkable similarity with that of the Hippelates flavipes, although they admit that there are localities where these flies are very common whereas yaws is unknown.

In view of the latter fact G. M. Saunders and co-workers (1936) consider it doubtful whether the Hippelates are a significant factor in the transmission of treponemes. From their publication it does not appear, however, that they have made a serious attempt at explaining the above phenomenon in some other way.

H. D. Chambers (1938) for the same reason thinks it doubtful whether the Hippelates should be considered as a vector. He rejects this possibility — in fact, without advancing adequate arguments — and in his monograph and other publications starts from the proposition that heat and humidity are the **only** predisposing factors in the incidence of yaws (vide also citation on page 36).

F. Nery Guimares (1952, 1953) and Florival C. Cunha (1952) on the other hand, state that the incidence of yaws in Brazil shows a striking agreement with that of the Hippelates. "Hippelates is a great transmitter (a) by direct ingestion and regurgitation or defaecation of infected matter and (b) by indirect carriage on proboscis, feet, wings etc."

The coastal region of the district of Ketapang, especially the examined area, is a habitat of flies of the Chloropidae family: the Siphunculina funicola (determination by Dr. Randell). These flies also occur in other regions in S. E. Asia. According to G. S. Granham-Smith (1930) they exist in India, Ceylon and Java; according to J. W. Field

(1935) also in Malacca. In Indonesia they are known as bari-bari and in the examined coastal region of Borneo, where they are a constant plague, as tjongok.
The flies show a marked preference for the sandy localities along the coast; on the latrite and loamy soil inland they are rare. Whether they appear or not probably depends on the humidity of the soil in which they burrow their eggs.
On sandy soil they disappear only on rainy days or after about a fortnight's spell of dry weather. Inland it is just the reverse; here they appear when the drought has continued for a similar period. Consequently I believe that their presence depends on the humidity of the soil, which in loamy and latrite areas is naturally different from that in sandy regions. Long spells of dry weather are rare in Ketapang and I think that this accounts for the hight incidence of the Siphunculina funicola at the coast and its rareness inland. The flies preferably feed on purulent exudate. They bear down upon the ulcerations in thousands; sometimes large wounds teem with flies. They stay in the neighbourhood of people and dogs and are „very persistent in their attention" (1948, Manson's Tropical Diseases). They are always found around inhabited huts but occasionally accompany people for hours in the open air.
The first congress on the combat against yaws, held at Bangkok (1952) where transmission by fliess was discussed, drew up the following conclusion: "It was considered probable that insects might play a role in spreading yaws, but that there was little incontrovertible proof of this".
If the flies of the family of the Chlorapidae do play a role in transmitting the traeponema pertenue, the yaws endemics might, in an epidemiological respect, be distinguished into two classes:

A) those which are transmitted by (direct and indirect) contact infections only;

B) those in which the H. flavipes or the Siphunculina funicola play an important role in transmitting the treponemes (the other species of flies mentioned are so much inferior in number to the Chloropidea that these may safely be left out of consideration).

This classification is based on the difference in infection hazard, which in the latter case is much greater than in the former.

The degree of the infection hazard is one of the factors governing:

a) the percentage of the population that will be infected;
b) the age at which infection is liable to occur for the first time;
c) the duration of papilomatosis in case this depends on the frequency of reinfection.

C. **May the new host, by this state of health or living habits, have an effect on the duration of papillomatosis?**

The treponema pertenue invades the new host via the skin; never has a mother yaw been found on mucous membranes. It is beyond any doubt that the treponemes are not capable of penetrating through an un-

impaired skin. The presence of a skin defect therefore is an essential condition for the dissemination of yaws. The larger the number of these skin defects the easier will it be for the treponemes to find a „porte d'entrée".

1. **The frequency of the skin defects** depends on:
   a) **the external trauma;** this includes all environmental factors such as vegetation, nature of the soil (roots, stones etc.), hygienic conditions in the kampongs etc., but also the frequency with which the people expose themselves to these traumata;
   b) **skin diseases:** scabies, epidermophyton, pityriasis versicolor (which, by scratching, may develop into infected or non-infected erosions), impetigo, impetigo bulbosa, i.e. diseases which, for the greater part, result from poor hygienic conditions;
   c) **duration of the skin defects.** People that have no got the faintest notion of wound treatment and hygiene stand a very great chance of acquiring secondary infections which, consequently, will prolong the duration of the skin defects.

It must be borne in mind, however, that the **general state of health** is the paramount factor on which the healing of the skin defects depends. Under-nourishment, malnutrition, chronic malaria, ankylostomiasis, etc. have to be reckoned among the principal causes responsible for the slow healing of skin lesions. However, **external conditions,** such as life on sandy soil, may also produce frequent secondary infections thus prolonging the duration of the skin defects.

A means of transmitting the treponema pertenue and the presence of a porte d'entrée are the two essential conditions on which the persistence of the yaws endemics depends. The degree of the infection hazard and the frequency of the skin defects determine:

a) the percentage of the population that will be infected;
b) the age at which the first infection mostly occurs;
c) the duration of papillomatosis in so far as it depends on the frequence of reinfection.

However, the duration of papillomatosis is also governed by factors other thans those mentioned above.

2. Localization of the mother yaw.

Although, strictly speaking, the location of the mother yaw does not have any effect on the duration of papillomatosis, a good understanding of what follows requires that a few words should be said about this point.

If, for example, 90 percent of the primary affects should be localized on thigs and nates, this might be taken as an indication of transmission by indirect contact. However, in those areas where 70 percent and more of the primary affects are found on the lower parts of the legs, this interpretation meets with difficulties because the lower extremities are not the most likely parts of the body for direct nor for indirect contact.

Consequently, the explanation for this phenomenon has to be sought in another direction: the lower parts of the legs are particularly exposed to external traumata, the resulting numerous lesions constituting a convenient porte d'entrée for the treponemes.

Many authors have found that the favourite location of the mother yaw is on the lower parts of the legs, e.g.:

T. B. Turner and G. M. Saunders (1935)	75%
H. D. Chambers (1938)	75%
R. van Nitsen (1944)	38%
R. D. Harding (1949)	87%
M. A. Vaucel (1953)	95%
A. Mackenzie (1925)	50%
Nepal Chandra Dey (1930)	70%
A. Tavares and co-workers (1949)	65%
Moss and Bigelow (1922)	ankles

Other workers, however, have reported entirely different findings.

G. M. Findlay (1946), for example, states that he found 57% of the mothers yaws to be localized on the thighs and nates; in Kenya, Nigeria, Nyassaland and S. Rhodesia the mother yaw seems to show a preference for the face (1953, Wld. Hlth. Org. Monograph XV, pp. 143—149).

In W. Borneo the following distributions have been found:

TABLE 28

	Coast	Inland
Lower extremities	70%	36%
Nates, regio analis, dorsal parts of thighs	14%	15%
Upper extremities	10%	18%
Head and neck	5%	19%
Trunk	3%	12%
Number of cases	102	74

The table shows that, although inland the favourite location is still on the lower extremities, the percentage is only half of that for the coast. In view of these figures it must be remarked that the explanation: frequent skin defects on the lower parts of the legs are the cause of the favourite localization of the mother yaw on this part of the body, is not completely horne out by the facts as will be shown below. The coastal region is thinly wooded and the roads are not in such a poor state as to constitute an equally important cause of traumata as those inland where the forests are much larger and denser. The frequency distribution of the locations, however, lend support to the belief that the Siphunculina funicola as a vector does play an important role in spreading yaws at the coast. These flies are found mostly near the ground and as the hands and arms are moved about much more than the legs, it is understandable that the flies confine themselves particularly to the lower extremities. It is justified, therefore, to expect that inland, where the Siphunculina funicola is hardly found, the localization will shift towards more typical points of contact on the body and not

show that partial preference for the lower extremities as was mentioned above.
R. D. Harding (1949) and H. D. Chambers (1938), both of whom noticed a preference of the mother yaw for the legs, think that this penomenon may be quit well explained by contact infection, due to living in cramped houses and sleeping close ogether, as was the case in the regions examined by them.
However, their explanation does not hold true for the examined area of Ketapang where the houses used to be very spacious as a rule.
Taking all in all, it seems that no definite epidemiological conclusions can be drawn on the favourite localization of the mother yaw; in any case the significance of this phenomenon can at best only be surmised, even if all the local cricumstances are known.

3. State of nutrition and duration of papillomatosis.

G. M. Findlay (1946) found that of 233 children without active yaws symptoms 3.8% showed clinical signs of malnutrition; in 47 children with yaws lesions, on the other hand, the percentage with distinct signs of malnutrition was as high as 14.7.
J. F. E. Bloss (1946) obtained similar results from an examination of negro tribes in the Sudan.

222 children (kampong Padang in the coastal region) were weighed and examined. 69 appeared to suffer from papillomatosis whilst the thers did not show active signs of yaws.

TABLE 29

	Children with papillomatosis		Children without active yaws symptoms	
Age	Number	Average weight	Number	Average weight
0	1	7.8	12	6.8
1	3	7.3	7	8.9
2	12	10.2	12	9.8
3	10	10.4	6	11.0
4	14	11.3	15	12.4
5	6	12.7	5	13.8
6	15	13.9	19	15.4
7	6	14.9	6	16.6
8	10	16.9	23	20.1
9	2	18.5	4	19.5
10	6	18.0	22	22.7
11	—	—	2	24.5
12	4	22.1	22	28.4

The numbers of children examined in the various age groups are too small to permit much importance to be attached to the differences in weight by themselves. However, the regularity with which these differences recur, without any exception, in the groups 3 to 12 justifies the assumption that the average weight of children with papillomatosis is

lower than that of children without active yaws symptoms.
The explanation of this phenomenon is anything but simple.

1. Papillomatosis is a disease which, probably, not only attacks the skin but also brings about changes in the whole human organism. If these phenomena have persited long enough it is not at all unimaginable that the body weight will fall owing to this morbidity.
Eny and Qualls (1952) report that they found the blood of yaws patients to be deficient in amino acids but do not express an opinion as to the question whether this deficiency must be considered either as the cause or as the result of the disease.
2. Another possibility is that the loss in weight is not caused by the disease but that papillomatosis manifests itself preferably, and for a prolonged period, in underweight children.

a) The percentage infection among ill-fed children is higher than among well-fed ones. Since in the coastal region practically all children of the age of 12 are infected (cf p. 24) it follows that the difference in susceptibility between the two groups — well and ill-fed children — cannot be a conclusive explanation.

b) The stage of papillomatosis in ill-fed children is longer than in well-fed children.

c) In ill-fed children the refractory towards papillomatosis develops more slowly than in well-fed ones. This implies that the former will be longer subject to reinfections resulting in active lesions. Considering furthermore that ill-fed children are more susceptible (point a) owing to the prolonged existence of the skin defects, we may say that the above difference in weight leads to the following conclusion: in the case of insufficient nourishment papillomatosis may be expected to last longer than in the case of adequate nourishment, because:
   1) the **symptoms** (papillomata) remain manifest for a longer period;
   2) the **refractory state** towards papillomatosis develops more slowly, with the consequence that reinfection is longer possible;
   3) the **susceptibility to reinfection** is greater.

   The significance of each of these factors by themselves is difficult to estimate.

4. Haemoglobin content and duration of papillomatosis.

We also measured, the haemoglobin content in blood samples taken from a large number of the children. The examination was carried out using the Tallquist scale in the way described on page 11.

TABLE 30
Haemoglobin contents

Hb. content	80 and higher	70	60 and lower
a) number of children examined (aged: 3—10)	36	106	50
b) number of cases of papillomatosis	10	48	26
c) (b) as a percentage of (a)	27.8	45.2	52.0

The lower the haemoglobin content the higher the percentage incidence of papillomatosis.
In explaining this phenomenon the same difficulties are encountered as mentioned under Table 29; moreover they run completely parallel to one another.
It is unlikely that an increase in susceptibility, accompanied by a decrease in haemoblobin content, would produce a difference in the percentage of infected children within each of the three groups mentioned, because practically every child in the coastal region has been infected before reaching the age of twelve.
For the same 3 reasons as mentioned above the cause therefore has to be sought again in an increase in the duration of papillomatosis, accompanied by a fall in haemoglobin content. It is also possible, however, that the fall in Hb-content is a result and not the cause of papillomatosis.

5. Age and duration of papillomatosis.

Finally, I believe that there are some indications suggesting that the character of papillomatosis varies with the age of the patient.

a) That children react differently from adults on the presence of treponemes appears from the fact that the clinical picture of lues congenita differs altogether from that of lues acquisita.

b)

TABLE 31

Numbers of papillomata counted in several age groups.

Age.	0—3	4—13	14 and older
a) Number of cases of papillomatosis	24	78	13
b) Number of papillomata	285	321	36
c) Average number of papillomata per patient	11.9	4.1	2.8
d) Number of patients with 10 or more papillomata	8	18	—
e) (d) as a percentage of (a)	33.3	23.1	—

The violence of papillomatosis seems to decrease with age. This cannot only be due to the circumstance that many of the cases observed in children from 0 to 3 years old were of a recent date, because in the children of 14 and older I did not meet with one case of a duration longer than 12 months. From Table 33 a on page 48 it will be seen that the eruptions are most violent in the period between 6 to 12 months after the start of the disease. Consequently, the larger the number of cases with a duration of 12 months and shorter, the larger the total number of papillomata. This may be the explanation of the difference between the groups 0—3 and 4—13, for it is obvious that the percentage of cases older than 1 year in the last group will be much higher than in the first. This does not account for the difference between the first two age groups and the third.

c) For a number of cases of papillomatosis I tried to establish the duration of the affects as accurately as possible. Interrogation, in which the dates of several important events during the year were used as a means for fixing the time at which the disease had started, enabled me to establish the duration for 120 cases with a reasonable degree of accuracy.

TABLE 32

Duration of papillomatosis in several age groups.

Age	0-3	4-13	14 and older
Number of cases of papillomatosis	23	74	14
Total number of months	151	1151	112
Average number of months per case	6.6	15.6	8.0

The data given in the table are by no means sufficient to enable a definite conclusion to be drawn. It should be borne in mind, however, that the collection of data is extremely difficult because papillomatosis is very rare among adults. Naturally, the average number of months for the age group 0-3 is much lower than for the group 4-13. That the average for the group 14 and older is also lower than that for the second might be due to the fact that the reaction in adults is of shorter duration and less violent than in children.

d) The reinfection hazard decreases with age. Older people use to wear more clothes than children; they are more inclined to cover their wounds up and do not expose themselves to traumata as often as children do. If reinfection actually has an effect on the duration of papillomatosis, this may also be a reason to assume that the duration decreases with the age of the patients.

The conclusion therefore is that the influence of age on the duration of papillomatosis has to be taken into account.

The above shows that the chances of being infected and reinfected, and hence the percentage of the population that will acquire an infection, as well as the age at which the first infection mostly occurs and also the duration of papillomatosis, may depend on:

A) the treponema pertenue: 1) type of strain;
2) temperautre and humidity;

B) the mode of transmission: 1) direct contact;
2) indirect contact;
3) vector;

C) the new host: 1) frequency of skin defects;
2) duration of skin defects;
3) state of nutrition;
4) haemoglobin content;
5) age.

Significance of reinfection.

In the foregoing attention has been drawn here and there to the possibility of reinfection. The reinfection hazard was mentioned for the first time in the discussion of reinoculation experiments which, as stated on

page 35, have made it clear that reinoculation mostly results in new lesions localized on and immediately around the inoculated spot. Generalized lesions due to reinoculation are rare.
Practice has shown that, years after the first infection, papillomata may occur that are to be ascribed to reinfections (p. 36). About the possibility of reinfection only little can be found in the literature; in fact, reinfection is only mentioned in connection with the periodic relapses of the generalized contagious forms occuring in some areas. It is unlikely, however, that reinfection does play a significant role here (see p. 36). On page 40 and 41 it was assumed that the degree of the infection hazard determines, amongst other things "the duration of papillomatosis in so far as this depends on reinfection".
The susceptibility to reinfection may be one of the factors that have an effect on the duration of papillomatosis (p. 44).
In the course of my own work I noticed several very remarkable facts which, I believe, can only be explained by assuming that reinfections resulting in a papilloma on the infected spot play a significant role, at least in so far as the coastal region is concerned.
In examining a large number of cases of papillomatosis, all the papillomata were counted while a record was kept of their localization on the body. Next, the patients, or their parents, were asked about the duration of the disease; for 110 cases*) the duration could this be established with reasonable accuracy.
The examination was carried out in the kampong of Padang in December 1952 and January 1953. The duration of the disease was classifide according to the periods given below:

I up to 5 months;

II 6 months to 11 months;

III 12 months to 2 years;

IV 2 years and longer.

The body surface was divided into 5 areas:

A. **Legs,** not including the dorsal upper part of the upper legs;

B. **Nates** and dorsal upper part of the upper legs;

C. **Arms;**

D. **Humid sites:** regio analis, perinealis, fossa axillaris; immediate surroundings of the mouth and the regio subnasalis; briefly, those areas generally known as favourite locations of the papillomata.

E. **Other parts of the body.**

---

*) This number does not agree with that mentioned on page 46. For some cases we only estimated the duration but somehow failed to count the papillomata.

TABLE 33a

Counted papillomata classified according to the duration of the disease and the localization.

Duration of the disease	Localization					Total	Number of patients
	A	B	C	D	E		
I	42	28	23	61	43	197	28
II	88	44	41	75	63	311	19
III	66	18	19	25	15	143	27
IV	79	9	21	23	17	149	36

TABLE 33b

Percentage localization of the papillomata per period.

Duration of the disease	Localization					Total
	A	B	C	D	E	
1	21.4	14.2	11.7	30.9	21.8	100
II	28.3	14.1	13.2	24.1	20.3	100
III	46.2	12.6	13.3	17.5	10.4	100
IV	53.1	6.0	14.1	15.4	11.4	100

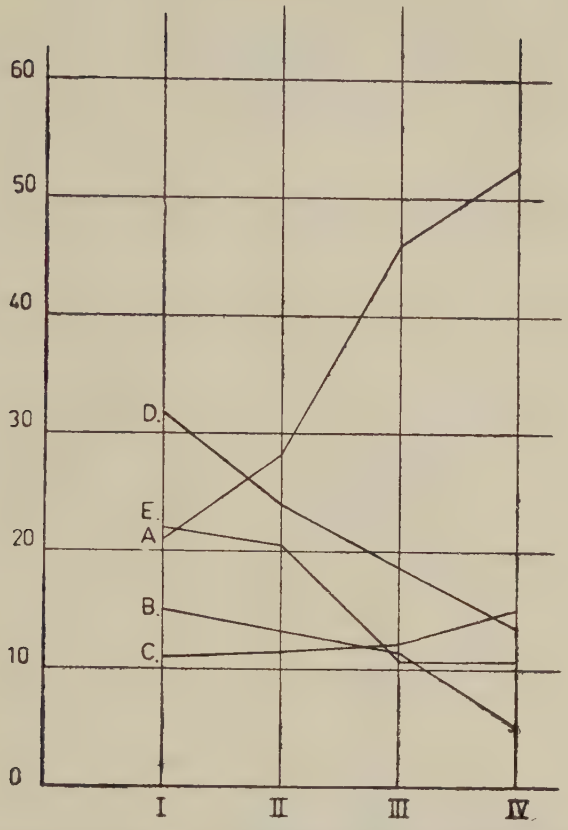
The data of this table are illustrated in graph IV.

If the character and duration of the generalized contagious stage should depend on the primary infection alone, there would not be any reason for supposing that the preference of the papillomata for a given part of the body would change during this stage. However, it is beyond any doubt that such changes do occur, and even to a marked degree.

The numbers of papillomata on the „humid sites", on the nates, dorsal side of the upper legs and on the „other parts of the body" vary in much the same way with the duration of the disease, that is to say the numbers of papillomata on these parts of the body diminish gradually as the duration of papillomatosis increases.

The papillomata on the arms and legs show the opposite tendency; the longer the duration of papillomatosis, the greater the preference of the papillomata to localize on the legs and also, though to a lesser extent, on the arms.

GRAPH IV
(see also Table 33b)



Shifting of the localization distribution with increasing duration of papillomatosis.

As the duration increases the „typical" distribution of the papillomata on the body gradually disappears, because the papillomata display a growing preferrence for the lower extremities.

The only possible explanation of this phenomenon is that reinfection is frequent. Reinfection will take place on the same parts of the body where the orignial infection — the mother yaw — is particularly liable to occur. As 70% of the primary affects at the coast where localized on the lower parts of the legs, it follows therefore that the majority of the reinfections occuring in this area will be found on the lower extremities. Starting from the supposition that:

1) the parts of the body classified under B, D and E are not exposed to reinfection and that
2) the arms and legs are not reinfected either during the first period (0—5 months)

it is possible to derive the number of papillomata occuring on the arms and the legs, for the three last periodes.

TABLE 33 c

Percentage localization of the papillomata in each of the four periods of the disease.

a) values of table 33 b
b) the same values after recalculation (dotted lines a. and c. in Graph V)

Duration of the disease	Localization				
	A		C		B.D.E. together
	a	b	a	b	a
I	21.4	21.4	11.7	11.7	66.9
II	28.3	18.2	13.2	10.2	58.5
III	46.2	13.0	13.3	7.1	40.5
IV	53.1	10.5	14.1	5.6	32.8

The percentage difference between the columns **a** and **b** is

	A	C
II	1.66	0.49
III	1.76	0.33
IV	1.80	0.35

This increase therefore must be due to reinfection. When the above percentage differences are converted to the corresponding numbers of papillomata per patient, we get:

	A	C
II	10.1	3.0
III	33.2	6.2
IV	43.5	8.5

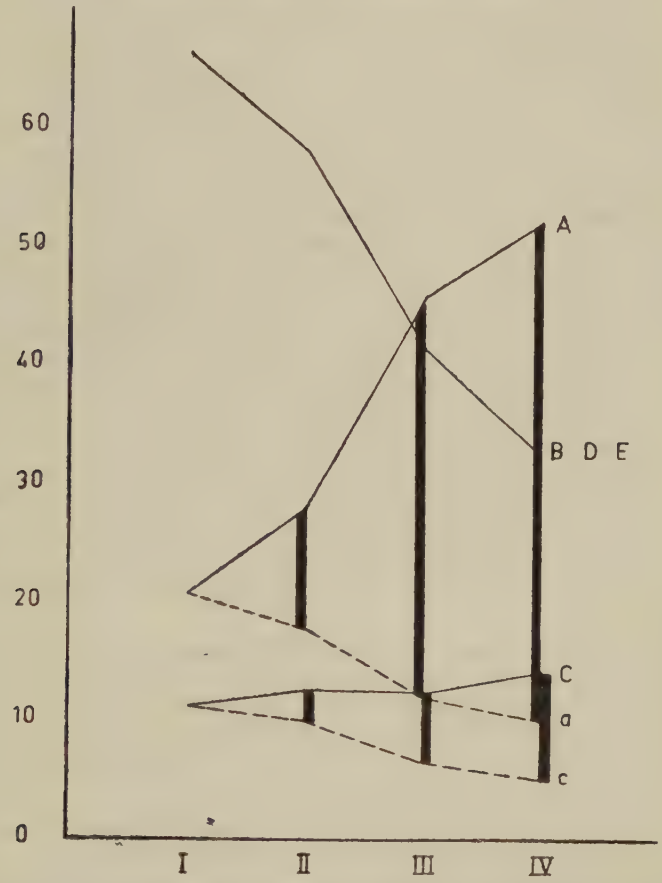
showing that the number of papillomata counted during the examination includes an average of at least two per patient that must have been caused by reinfection.

The actual frequency of reinfection, however, is very difficult to estimate. Nevertheless, as the individual papillomata are usually healed after a period varying from 3 to 4 weeks, it may safely be taken that reinfection wil be veren frequent, that is to say at least in the coastal region.

GRAPH V

(c.f. Table 33)

Calculated number of papillomata on arms and legs as a percentage of the total number of papillomata per period if these parts of the body are not reinfected. Lines a and c.



(Lines A and C are identical to those in Graph IV on pag. 49. Line B+C+E is a combination of the lines B, D and E in Graph IV on pag. 49. The percentage increase in the number of papillomata on arms and legs is given by the thick vertical lines)

It is difficult to indicate the exact period after which the generalized contagious stage terminates, to be superseded by the development of one or more isolated papillomata, caused by reinfection. However, the number of papillomata on the majority of the patients suffering from the disease for a period of 2 years or longer is so small (8 with 1, 8 with 2, 4 with 3 and 7 with 4) that one cannot but suppose that in most of them the generalized stage has come to an end, and that the affects ob-

served are merely the result of a prolongation of papillomatosis by reinfection.
The significance of reinfection for the duration of papillomatosis will highly depend on the infection hazard.
As regards the coastal region of Ketapang it must be considered unlikely that the frequent reinfections observed here are produced by direct and indirect contact. These may be safely put down to the influence of the Siphunculina funicola.
As briefly stated already on page 39, K u m m and co-workers found that treponemes, after staying for 7—8 hours in a diverticulum of the esophagus of the Hippelates pallipes (which just as the Siphunculina funicola belongs to the family of the Chloropidae), may be still be found alive in regurgitated matter. That these regurgitated treponemes are still capable of transmitting the disease appears from the following experiment. In 63 rabbits K u m m inoculated the treponemes into granular lesions and found that 4.8% of the rabbits showed a positive reaction. When Hippelates that had fed in the usual way on the secretum of papillomata were physiologically contacted with skin defects produced in 68 rabbits, a positive result was observed in 7 cases (10.3%).
R.E. R o c k (1953) approached the vector problem from a different side. He combined his anti-yaws campaign in Guam with a fight against flies and found that in a village where no attention had been paid to the destruction of flies, the results of his main campaign were much poorer than in another village where the flies had been vigorously fought. All other conditions in the two villages were in general equal.
The significance of the Siphunculina funicola as a vector of the treponema pertenue in the coastal region of Ketapang may be summarized as follows:

1. the favourite localization of the mother yaw on the lower parts of the legs can be reasonably accounted for by assuming that the Siph. funicola plays an important role in spreading yaws. Otherwise, the localization would have to be ascribed to contact infection; however, having regard to the way of living of the coastal population, the latter possibility must be rejected.
2. I am of the opinion that the above explanation also holds — and with greater force — for the change in localization of the papillomata during the contagious stage. Also this phenomenon can only be understood by supposing that the Siph. funicola acts as an important vector of yaws.

Review of the factors that have to be considered in estimating the duration of papillomatosis.

1. character of the treponema strain;
2. temperature and humidity;
3. rate of development of the refractory state. This may depend on:
   a) general state of health;
   b) age.

4. reinfection hazard. This depends on:
   a) frequency and duration of the portes d'entrée;
   b) mode of transmission of the treponema.

It will be clear from this that the duration of the stage of papillomatosis need by no means coincide with the period required for the development of the refractory state; probably this will not be case as a rule. Turner's experiments (pag. 35) which have shown that reinfection may take place many years after the first infection, raises the question whether there is any point in seeking for a relationship between the duration of papillomatosis and the rate at which the refractory state develops.

However, as long as no answer has been found to the question whether the frequency of reinfection has any affect on the development rate of the refractory state, it would seem incorrect to deny the existence a relationship between the refractory condition and the duration of papillomatosis. It might be for instance that in case reinfection should occur very frequently, the development of the refractory condition will proceed at a faster rate, with the result that the time needed for the latter process would coincide with the duration of papillomatosis.

CHAPTER V

TO WHAT DIFFERENCES BETWEEN THE INLAND AND COASTAL REGIONS IS THE DIFFERENCE IN THE DURATION OF PAPILLOMATOSIS TO BE ASCRIBED?

A. The Treponema. Possibly, the treponema strain occuring inland differs from that found in the coastal region. We were not in a position to investigate this. As the treponema may be influenced by temperature and humidity, the question whether the two regions have the same climate is of importance. Rainfall, temperature and degree of humidity are practically equal, but the temperature amplitude inland is about 2°C greater than that of the coastal region.

B. In the coastal region **infection is much more likely** to occur than inland.

1. Inland, **the spread of the population** is far greater than in the coastal region. The preferred habitation of the Dyaks is the woods around the rice-fields, far away from the regular kampongs. Even if all other factors influencing the infection hazard should be the same for the two regions, this one by itself would cause a wide difference between the endemics.

2. **The living habits** — which term here refers to the kind of personal contact by which the treponema can be transmitted, either directly or indirectly — should be considered next. If there is any difference at all, it might be said that personal contact is more intensive among the Malayans than among the Dyaks.

3. A wide difference is found in **clothing.** Most Malayan men wear trousers and women sarongs. The Dyaks, on the other hand, are as a rule very scantily dressed. Among children there is hardly any difference on this point, however, so that the importance of clothing differences are largely cancelled out.

4. **The way of transmission.** If the flies of the Chloropidae family are to be considered as vectors — and there seems to be much evidence in support of this opinion — the Siphunculina funicola causes an essential difference between the two regions as regards the way of transmission: whereas these flies are frequent in the coastal region, they occur only sporadically inland.

C. The „porte d'entrée".

1. In the heavily wooded inland external traumata are much more frequent than in the coastal region, where the roads are well practicable and where the jungle had disappeared, at least in the populated areas. It is much to be doubted, however, whether this difference exerts any influence on the frequency of external traumata in children.

2. Actually, the number of ulcerations in children and adolescents is much lower inland than in the coastal region. In our fight against yaws every serious skin defect with a purulent secretion was diagnosed as an „ulcus", unless other typical skin defects enabled us to make a more specific diagnosis. The data thus obtained and those collected during the rounds may be considered to give a fairly correct idea of the frequency of ulcerations. Fairly, because the figures give an incorrect picture of the situation in the coastal region. In this area ulcerations very often occur in combination with papillomatosis, in which case they are not included in the table below.

TABLE 34.

	Coastal region		Inland	
Age group	3—10	11—18	3—10	11—18
Number of persons examined	1306	568	1662	1615
Ulcerations (‰)	26.9	23.3	6.6	8.7

The table shows that the number of ulcerations in persons belonging to the younger age groupe is considerably greater in the coastal region than inland. This difference may be ascribed to various causes:

a. The Dyaks eat better food than the Malayans. The Dyaks have much meat, forest greens, and sufficient — often more than sufficient — rice at their disposal, whereas the Malayans have only little meat and greens, and frequently lack even sufficient amounts of rice.

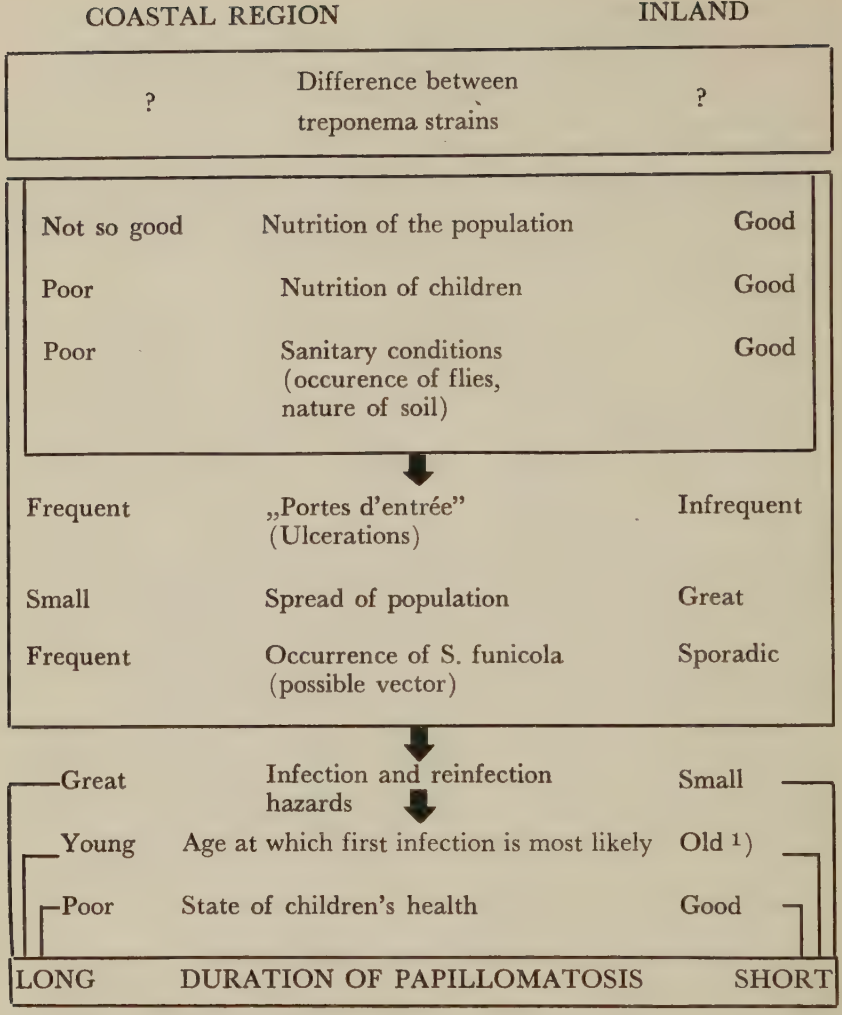
b. Inland, the Chinese traders have put up their shops in the largest villages only, whereas in the coastal region they sell their goods everywhere. This involves a serious evil: the Malayan children eat lots of sweets; among the Dyaks sweets are still unknown. In my opinion this evil has a bad influence on the state of nutrition of the children in the coastal region. Both their food in general and their **eating habits** compare unfavourably with those of the Dyak children.

c. The **Siphunculina funicola** must be considered as a vector not only of the treponema, but also of all kinds of bacilli, bacteriae and cocci. The frequent occurence of this vector will considerably contribute to the infection of normal skin defects and will prevent the healing of ulcerations. It need hardly be remarked that nobody in these regions so much as thinks of dressing or treating his wounds.

d. The **sandy soil** of the coastal region, the territory of the Malayans, constitutes a permanent hazard: skin defects are easily contaminated, especially in children.

From the foregoing it can be concluded that in the coastal region sanitary conditions are worse than inland, which is due to a number of unfavourable circumstances, e.g. the occurence of flies, the sandiness of the soil, etc.

Survey of the differences between the coastal and inland regions which have to be considered in accounting for the difference in the duration of papillomatosis.



A series of factors, part of which are purely accidental, favour the occurrence of yaws endemics in the coastal region. Inland, the unfavourable conditions are absent.

Although geological, sociological and economic factors each exert their own influence, their individual importance cannot be estimated outside the whole complex. If, for instance, the coastal region had a different soil, the yaws endemic should be of an altogether different character. In spite of this, it would not be justified to ascribe an endemic to geological conditions only. Similar considerations apply to nutrition, the occurrence of flies, sanitary conditions, temperature, humidity, etc. The

[1]) As compared with coastal region.

importance of each factor can be estimated only if it is considered as part of a complex, which is so extensive that yaws may be called an endemic which is linked up with all conditions under which this people lives.

Inland, the existence of the yaws endemic is only just possible: its continuation is due to insufficient clothing and sanitary conditions. Mass treatment and some improvements in clothing might suddenly stop the endemic.

Naturally, it would be much more difficult to stop the endemic in the coastal region. Here, mass treatment cannot be expected to yield other than temporary results, unless it were attended by very intensive wound dressing and considerable improvements in children's clothing and in sanitary conditions in general.

CHAPTER VI

HOW IS THE DIFFERENCE IN THE FREQUENCY OF PALMAR AND PLANTAR LESIONS BETWEEN THE INLAND AND COASTAL REGIONS TO BE EXPLAINED?

In the coastal region the percentage of people with palmar and/or plantar lesions is 5.2; the corresponding figure for the inland region is 20.8 (see table 20), so that the difference in frequency is 15.6%. This figure also applies to the difference in relative frequency, the percentage of yaws cases inland being about equal to the percentage found in the coastal region.

In this chapter an attempt wil be made to account for this enormous difference in frequency.

The method we followed for our investigation is similar to that used for studying papillomatosis. The conditions under which certain yaws lesions may occur were examined, and by means of the data thus obtained we tried to discover a regularity, which was then applied to a comparison of the yaws endemics in the two regions.

Papillomatosis was studied mainly in the coastal region, where it is most frequent; an investigation into the occurence of palmar and plantar lesions was carried out mainly inland. Unless explicitly stated, all data given below refer to the inland population.

This study will not be restricted to palmar and plantar lesions, but it will also comprise other, later forms, as far as these throw more light on certain phenomena observed in palmar and plantar lesions.

Just like all later forms of yaws, palmar and plantar lesions are in essence a manifestation of the fight between the treponema pertenue and its host. The development of later forms of yaws depends on three factors:

(1) the treponema pertenue;

(2) the host;

(3) accidental external circumstances.

The influence of the host may be called twofold:

— during the infection specific changes take place in the host which may — or may not — predispose him to develop certain later forms of yaws;

— also non-specific circumstances, however (in particular the state of health), may have an effect on the development of these later forms.

In view of what had just been said we will split up this chapter into four parts:

1. the influence of the treponema (C),
2. the influence of specific changes in the human organism (D),

3. the influence of non-specific factors, e.g. the state of health of the host (A),

4. and the influence of external circumstances (B), on the development of skin defects in the later stages of the disease, in particular on the development of palmar and/or plantar lesions.

The order in which these factors will be discussed (A - D) differs from the order in which they have just been enumerated. The latter two points are dealt with first, as the lesions will here be regarded as independent symptoms. The former two points are discussed last and in this discussion an attempt will be made to find a relationship between the course of the disease from the start of the infection, and the occurrence of later forms (in particular palmar and/or plantar lesions).

A. Does the general state of health exert any influence on the prevalence of palmar and plantar lesions?

1. During a tour along the upper reaches of the river Djelei special attention was paid to this question. The most reliable and objective data were the figures for splenic index and haemoglobin content. These were determined in 3000 people. Of the 14 villages we visited, only 5 yielded such data as were considered worth elaborating. In the 9 remaining villages sufficient co-operation of the inhabitants was lacking. The following table refers to those vilages where people turned up in sufficient numbers:

Name of village	Number of inhabitants	Number of people examined	% people examined
Tandjung Djelei	628	426	68.0
Pering Kunjit	369	289	79.9
Pessangeran	235	179	76.1
Pendengeran	126	125	99.5
Silat	136	123	90.5

In Tandjung Djelei people were much more co-operative than would be judges from the figures: one of the smaller communities belonging to the village had not been warned, so that the whole group — although included in the number of inhabitants — failed to turn up for examination.

The yaws lesions were recorded by the author; the splenic indices were determined by the malaria mantri, an inland nurse specially trained for this work; for the latter examination the people had to lie down. Cases of splenomegaly were not classed into groups.

Only adults were examined. In young people palmar and plantar lesions are brought about by papillomatosis.

Consequently, the main factors that play a part here are epidemiological in nature. Later stages of palmar and plantar lesions — those observed in adults — no longer show this close relationship to papillomatosis: other factors come to play a part in the development of these lesions.

GRAPH VI.

Percentage of palmar and/or plantar lesions in people with (////) and without (: : : :) splenomelagy.

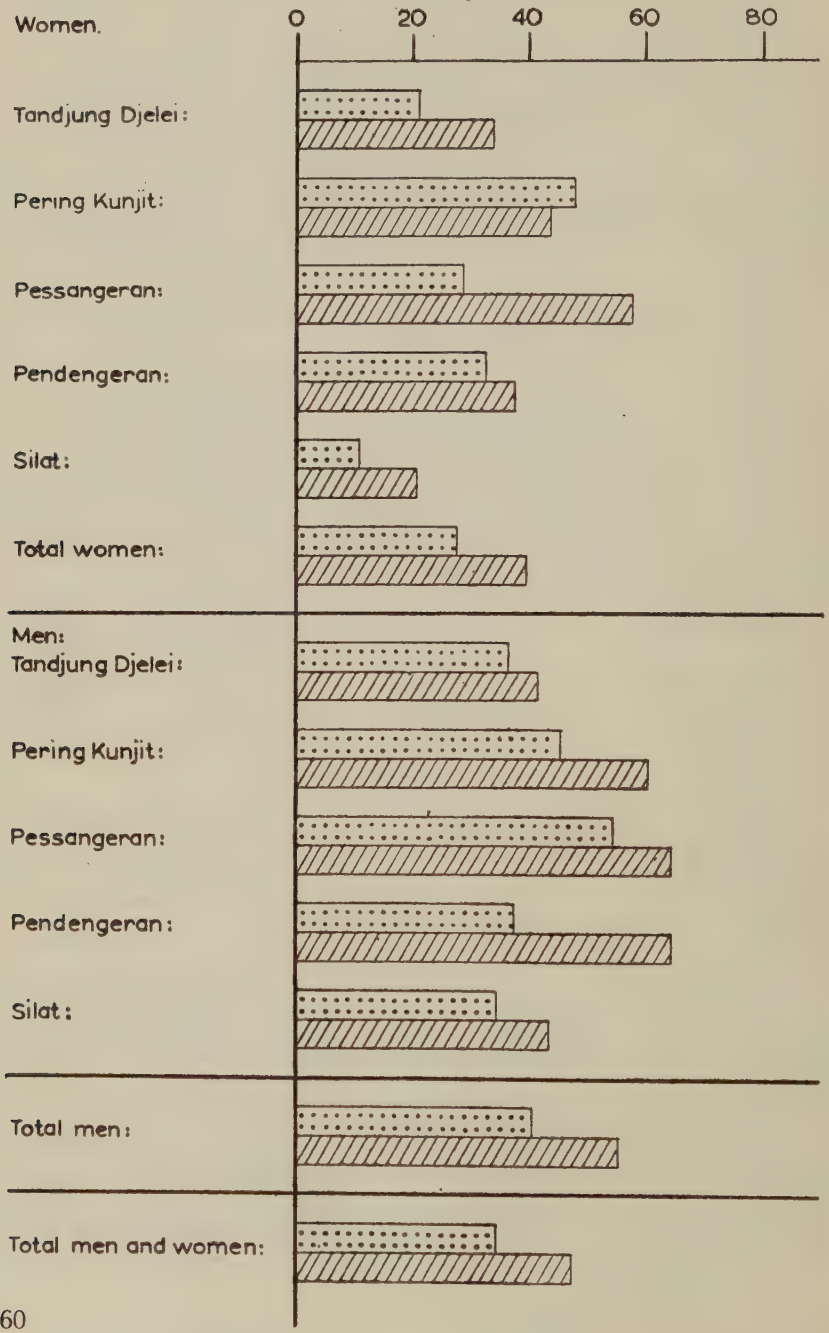


TABLE 35

Relationship between splenic index and palmar and/or plantar lesions in 645 adults.

	People without splenomegaly			People with splenomegaly			Total number examined
Women	Total	+	%+	Total	+	%+	
Tandjung Djelei	72	15	21	50	17	34	122
Pering Kunjit	42	20	48	43	19	44	85
Pessangeran	24	7	29	26	15	58	50
Pendengeran	15	5	33	21	8	38	36
Silat	19	2	11	14	3	21	33
Total	172	49	28	154	62	40	326
Men							
Tandjung Djelei	63	23	37	38	16	42	101
Pering Kunjit	41	19	46	46	28	61	87
Pessangeran	20	11	55	26	17	65	46
Pendengeran	29	11	38	23	15	65	52
Silat	17	6	35	16	7	44	33
Total	170	70	41	149	83	56	319
Total men + women	342	119	35	303	145	48	645

(The colums headed + refer to people with palmar and/or plantar lesions).

The relative number of people with palmar and/or plantar lesions is considerably higher among people suffering from splenomegaly than among those who have no splenic enlargement. This applies not only to the total number of people examined but also to every group by itself, with the exception of the group formed by the Pering Kunjit women. See also graph VI.

The conclusion that can be drawn from these data is of very great importance:

Whether a person who has been infected by the treponema pertenue will develop palmar and or plantar lesions depends, in part on the question whether he or she is periodically infected bij malaria parasites.

In addition to the 264 cases of palmar and/or plantar lesions, 32 other non-contagious forms of yaws were discovered. (The actual number was higher thans 32, but in the majority of cases a combination with palmar and/orf plantar lesions was observed).

With respect to splenomegaly these cases were distributed as follows:

TABLE 36.

	No splenomegaly	Splenomegaly
Number of people examined	342	303
Number of „other non-contagious forms"	14	18
Percentage	4.1	5.9

Here also, a difference in the percentage is observed. The number of cases is too small to justify a conclusion, however.

2. It is obvious to suppose periodic malaria infection to manifest itself not only in splenomegaly but also in a fall of the haemoglobin content. Therefore, our next step was to investigate the possibility of a correlation between the haemoglobin content and the prevalence of palmar and plantar lesions. The method used for the determination of the haemoglobin content has already been described in detail (page ...). Determinations were made by means of the Tallquist scale. The same scale and the same type of filter paper were used throughout the investigation. The various operations — taking of the drops of blood and checking against the scale — were always carried out by one and the same person.

According to their haemoglobin contents the people examined were classed into three groups:

haemoglobin content: 80 and higher
70
60 and lower.

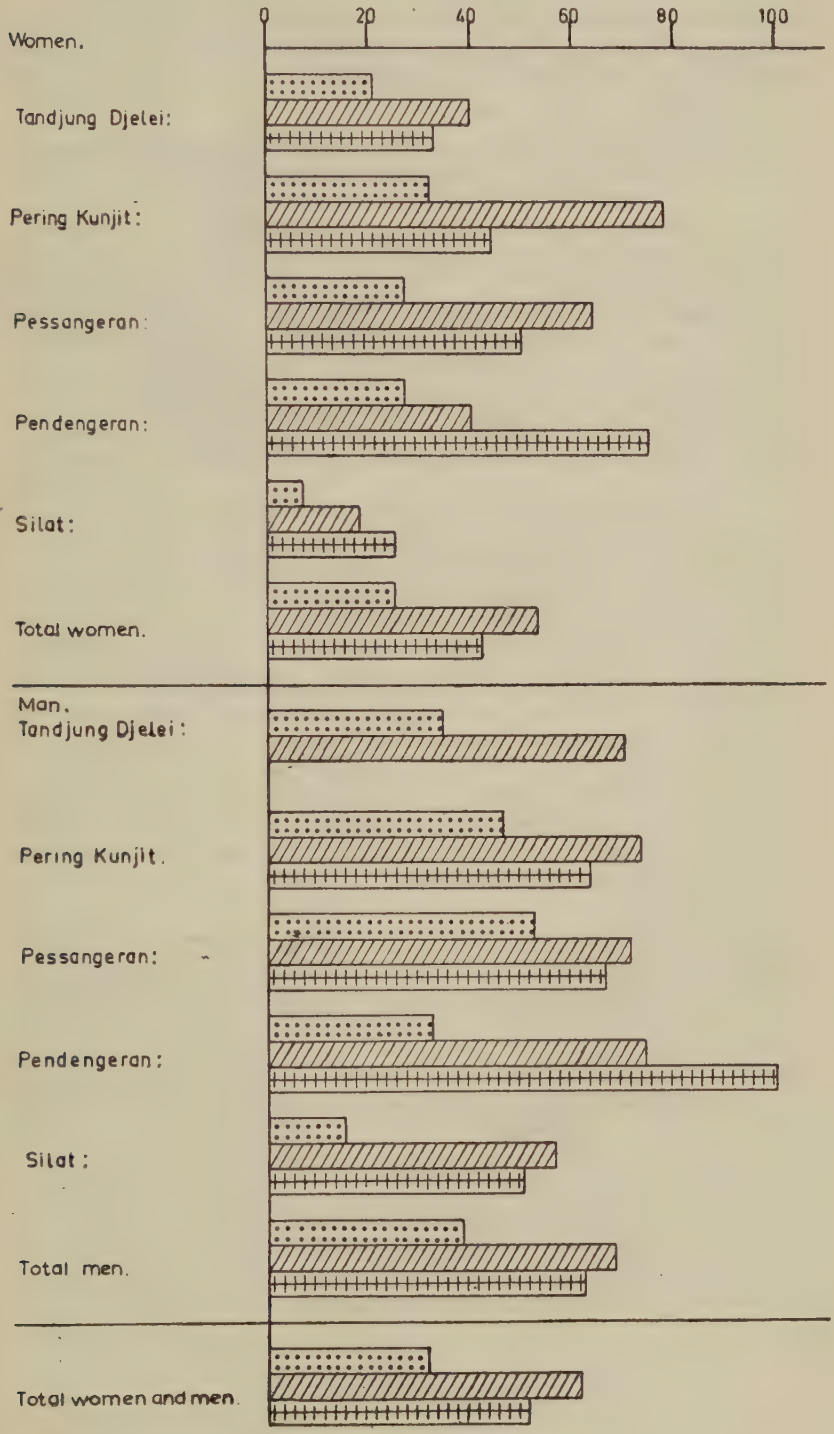
TABLE 37.

Relationship between haemoglobin content and palmar and/or plantar lesions in inland men and women.

	80			70			60		
Women	Total	+	%+	Total	+	%+	Total	+	%+
Tandjung Djelei	93	20	21	26	11	40	3	1	33
Pering Kunjit	53	17	32	33	18	78	9	4	44
Pessangeran	26	7	27	22	14	64	2	1	50
Pendengeran	22	6	27	10	44	40	4	3	75
Silat	14	1	7	11	12	18	8	2	25
Total	208	51	25	92	49	53	26	11	42
Men									
Tandjung Djelei	83	28	34	17	11	70	1	0	0
Pering Kunjit	57	26	46	22	16	73	8	5	63
Pessangeran	23	12	52	17	18	71	6	4	66
Pendengeran	31	10	32	19	14	74	2	2	100
Silat	13	2	15	16	59	56	4	2	50
Total	207	78	38	91	62	68	21	13	62
Total men and women	415	129	31	183	111	61	47	24	51

GRAPH VII.

Percentage of palmar and/or plantar lesions in people belonging to haemoglobin groups 80 (: : : :), 70 (/ / / /), and 60 (+ + +).



(The columns headed + refer to people with palmar and/or plantar lesions).
The figures referring to the total number of people examined show that:

a. the percentage of palmar and/or plantar lesions is much lower among people having a haemoglobin content of 80 or over than among people with haemoglobin contents of 70 and 60;

b. the percentage of people suffering from palmar and/or plantar lesions is higher in the "70" group thans in the "60" group.

These observations apply not only to the total number of people examined, but also to the various individual groups of men and women. The regularity here observed is seen to remain in force even if we consider the situation in individual kampongs, although here some deviations from the rule are to be noted, which is only natural in view of the small numbers of people examined (cf. Graph VII).
Deviations from the „total" column in the percentage proportions are found in the kampong divisions only in haemoblobin groups 70 and 60, for the kampongs of Pendengeran (men and women) and Silat (women).
The conclusions that can be drawn from Table 37 are of great importance: obviously, there is a correlation between the number of palmar and plantar lesions and the height of the haemoglobin content. We must assume that in each of the three groups of haemoglobin contents the same percentage of people have been infected by the theponema. The fact that the number of palmar and/or plantar lesions among people belonging to the 70 and 60 groups is decidedly greater than among the 80 group justifies the conclusion that a person with a low haemoglobin content is more likely to react with palmar and/or plantar lesions than a person with a normal haemoglobin content.
The first question that presents itself is whether this phenomenon may be accouted for by assuming that palmar and plantar lesions are more persistent in people with a low haemoglobin content than in persons with a normal haemoglobin content.

The cases referred to in the above tables may for the greater part be classed under the heading keratodermia. They manifest themselves in very coarse lesions, characterized by a strongly thickened, scaly skin, which is hard and stiff and sometimes cracked, and which often shows painful fissures. The people examined — at least those who had an opinion of their own on the point — declared that these lesions do not heal spontaneously. They may disappear when the sufferer stops walking for a very long time, e.g. a year. This is of no practical importance, however. Sometimes the lesions disappear after a considerable number of years, in which case a thin, atrophic, scar-like spot is left in the skin. My personal opinion is that there are some palmar and plantar yaws lesions (e.g. in the early stages of the disease) that do heal spontaneously, but I think that among the cases we encountered in adults of the inland region spontaneous regression must be called

exceptional. Moreover, if one should yet like to maintain that in people with a normal haemoglobin content the lesions tend to heal spontaneously sooner than in people with a low haemoglobin content, it may with as much reason be argued that people with a normal haemoglobin content will not develop then so easily as people with lower haemoglobin contents.

Whether a person who has been infected by the treponema pertenue will react with palmar and or plantar lesions depends, in part on the haemoglobin of his blood.

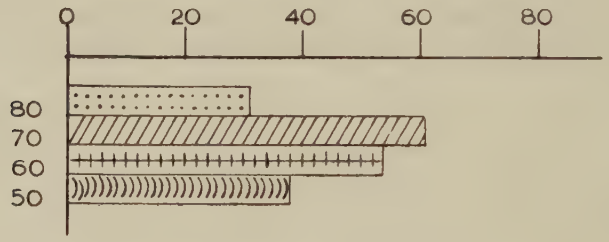
It is obvious to put the question why the number of palmar and plantar lesions is lower among people with haemoglobin contents under 70. This fact seems to contradict our foregoing remarks, according to which the number of palmar and plantar lesions rises as the haemoglobin content falls off.
This remarkable phenomenon comes to the fore even more strongly if we make a division into haemoglobin content groups 80, 70, 60, and 50 and lower.

TABLE 38.

Haemoglobin content group	80	70	60	50 and lower
Number of people examined	415	183	39	8
People without palmar and plantar lesions	286	72	18	5
People with palmar and/or plantar lesions	129	111	21	3
% people with palmar and/or plantar lesions	31	61	54	38

GRAPH VIII.

As the „Total Men + Women" column in Graph VII, for haemoglobin content groups 80, 70, 60 and 50.



Although the low figures of the last column, 5 and 3, are not by themselves significant, they very clearly underline the remarkable fact that the percentage of people with palmar and plantar lesions increases when the haemoglobin content becomes lower than 70.
This phenomenon will be explained in the following section of this chapter.
It is an obvious assumption that the splenic index and the haemoglobin content are connected in the same way with the occurence of palmar and/or plantar lesions, for both are affected by periodic reinfections by the malaria parasite. However, this is not the case. Although the two factors are, of course, related, their proportions to the number of palmar and plantar lesions by no means run parallel.
This is shown in Table 39. As a division according to the kampongs in which investigations were carried out would here lead to figures which are so small as not to permit of expressing percentages, we give the total figures only.

Table 39 contains all the conclusions that can be drawn from the foregoing tables (35, 36, 37 and 38):

(a) A decrease in the haemoglobin content is accompanied by a rise in the percentage of palmar and/or plantar lesions.

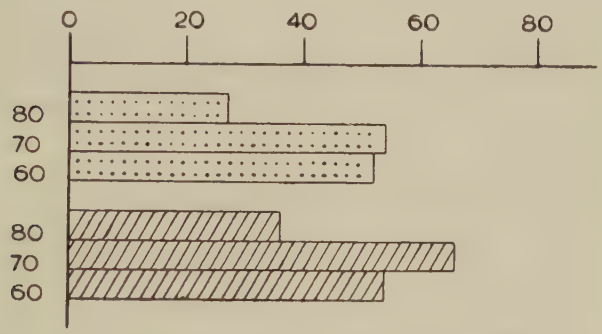
(b) When the haemoglobin content falls below 70, the number of

TABEL 39.

content groups Haemoglobin	Number of people without (—) and with (+) splenomegaly	Number of people with palmar and/or plantar lesions
80	—241 +174	66 = 27 % 63 = 36 %
70	— 80 +103	43 = 54 % 68 = 66 %
60	— 21 + 26	11 = 52 % 14 = 54 %

GRAPH IX.

Percentage of palmar and/or plantar lesiosn in people with (/ / / /) and without (: : : :) splenomegaly belonging to various haemoglobin groups.



palmar and plantar lesions is seen to decrease.

(c) The percentage of palmar and plantar lesions is lower among people without splenomegaly than among those suffering from plenic enlargement.

(d) The foregoing remark applies to every individual haemoglobin content group, which proves that splenomegaly and lowering of the haemoglobin content are, to a certain extent, independent as far as their relationship to the occurence of palmar and plantar lesions is concerned.

3. It is obvious that these two factors, splenomegaly and lowering of the haemoglobin content, are not the only ones influencing the frequency of palmar and plantar lesions. In these regions the serious character of ankylostomiasis also has an undeniable influence on the prevalence of palmar and plantar lesions. This influence is probably analogous to the influence exerted by the periodic reinfections by the malaria parasite. An extensive investigation in which objective data are

obtained on the prevalence and the seriousness of ankylostomiasis cannot be carried out in the jungle.
An important role may be played by differences in the state of nutrition. Although in general the Dyaks are well fed, individual differences may occur, with the possible result that one person will more easily contract palmar and/or plantar lesions than another. This could not be proved in practice either, in the first place because no great differences in nutrition were observed in adults.
However, the tables given above have, in my opinion, made it sufficiently clear that the state of health of the population has an influence on the frequency of occurence of palmar and plantar lesions.
For the sake of completeness it should here be added that in the literature on the subject a number of data are given that likewise point to an influence of the state of physical health on the character of the later forms of yaws.

Baermann pointed out (1927) that there exists a relationship between the seriousness of yaws lesions in general and the state of health.

Shircore stated (1930) that a poor diet, particularly one containing little animal albumen, fats, milk, calcium and vitamin A, predisposes people to contract late forms of yaws, in particular osteoporotic lesions.
Aars and Nielsen (1938) determined the cholesterol content in the blood of people having yaws lesions and found a lowering in people with active lesions.

Along the upperreaches of the river Lauer, far into the Ketapang inland, a group of Dyaks and a group of Malayans living very close together were examined. Among the Dyaks no serieus late forms of yaws were found, whereas many Malayans proved to suffer from ulcerative and gummatous lesions attended with mutilations. There was a very distinct difference between the two groups as regards the state of nutrition, the Malayans being poorly fed (cf. p. 15).
We may conclude that there are indications that the general physical state exerts an influence not only on the frequency of later forms of yaws, but also on their nature.

B. Are there any external conditions that may have an effect on the frequency of palmar and plantar lesions?

The influence of the chronical trauma.

Anybody who has only a slight knowledge of yaws will not doubt that the trauma has an important influence on the occurence of this disease. In areas where yaws are endemic everybody, whether physician or layman, knows that plantar lesions are mainly found in farmers. Serious plantar lesions are far more difficult to heal in walking patients than in people who, for some reason or other, are not ambulant.
The great difference between the inland and the coastal region as regards the frequency of plantar lesions occasioned us to investigate the influence of walking on the formation of plantar lesions. The fact

of the matter is that the inland Dyak walks much more than the Malayan of the coastal region. Could this be the cause of the great difference in the prevalence of plantar lesions?

1. **The frequency of plantar lesions in men and women** [1])

TABLE 40.

Number of palmar and/or plantar lesions in men and women of the coastal region.

Men					
Age group	0—2	3—10	11—18	19—	Total
1. Number examined	197	689	255	797	1938
2. Number of persons having lesions	—	14	11	101	126
3. (2) as a percentage of (1)	—	2.—	4.3	12.8	6.5
Women					
1. Number examined	170	649	377	919	2075
2. Number of persons having lesions	—	11	14	56	81
3. (2) as a percentage of (1)	—	1.7	3.7	6.1	3.9

In the coastal region plantar lesions are much more frequent in men than in women.

TABLE 41.

Number af palmar and/or plantar lesions in inland men and women.

Men.					
Age group	0—2	3—10	11—18	19—	Total
1. Number examined	109	363	175	748	1395
2. Number of persons having lesions	—	15	34	158	207
3. (2) as a percentage of (1)	—	4.1	19.4	21.1	14.8
Women					
1. Number examined	115	346	147	714	1322
2. Number of persons having lesions	—	13	22	71	116
3. (2) as a percentage of (1)	—	3.8	15.—	10.—	8.8

Also inland, plantar lesions are much more frequent among men than among women. (This also appears from tables 35 and 37).
Before definite conclusions can be drawn from these tables it is necessary to investigate whether men and women are infected by the treponema with the same frequency. To obtain a picture which is as reliable as possible the numbers of cases of polypapillomatosis among men and women should be compared.

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[1]) The number of palmar lesions not accompanied by plantar lesions is so small that tables 40 and 41 may be considered to relate to plantar lesions only.

TABLE 42.

Frequency of polypapillomatosis in men and women of the coastal region

Men					
Age group	0—2	3—10	11—18	19—	Total
1. Number examined	197	689	255	797	1983
2. Number of persons having papillomatosis	17	91	3	5	116
3. (2) as a percentage of (1)	8.6	13.2	1.2	0.6	6.—
Women					
1. Number examined	170	649	337	919	2075
2. Number of persons having papillomatosis	19	81	6	2	108
3. (2) as a percentage of (1)	11.1	12.5	1.8	0.5	5.2

There is a small difference as regards the frequency of polypapillomatosis between men and women. Bearing in mind, however, that in the coastal region 87 % of the school-children have already had the infection (cf. p. 24), we must conclude that, if in the coastal region there is any difference at all between men and women in this respect, it must be called very small indeed. The difference in infection cannot possibly account for the difference between men and women as regards the frequency of plantar lesions.

TABLE 43.

Frequency of polypapillomatosis among inland men and women.

Men					
Age group	0—2	3—10	11—18	19—	Total
1. Number examined	109	363	175	748	1395
2. Number of persons having papillomatosis	1	18	4	3	26
3. (2) as a percentage of (1)	1.—	5.—	2.3	0.4	1.9
Women					
1. Number examined	115	364	147	714	1322
2. Number of persons having papillomatosis	1	12	2	4	19
3. (2) as a percentage of (1)	0.9	3.5	1.4	0.6	1.4

Here, too, there proved to be a difference between men and women as regards the frequency of polypapillomatosis. In other inland areas similar observations were made: Among 1055 men older than 10, 18 (1.7 %) were found to have papillomatosis.

Among 791 women older than 10, 11 (1.4 %) suffered from papillomatosis.

However, inland the number of papillomatosis cases is so small that it is difficult to draw a definite conclusion as to the percentages of men

and women that are infected. As the majority of them are infected below the age of 10, and there is no question of a wide difference in living habits between boys and girls below this age, I do not think that the above-mentioned difference between men and women as regards infection percentage suffices to account for the great difference between inland men and women as regards the percentage of plantar lesions.

The difference in the percentage of palmar and plantar lesions between men and women proves much more pronouced among adults than among young people.

This is clearly shown by the quotient $\frac{\text{percentage men}}{\text{percentage women}}$, given for various age groups in tables 40 and 41:

Age:	3—10	11—18	19—
Coastal region:	1.20	1.16	2.08
Inland:	1.10	1.30	2.12

Both in de coastal region and inland there is a very distinct difference between men and women as regards the percentage of palmar and or plantar lesions.

A reasonable explanation of this difference can only be found in the difference that exists between men and women as regards the stress exerted on the palms of the hands and the sole of the feet. In young people this difference is not nearly so great as in people of older age-groups, so that the difference percentage is accordingly smaller.

This conclusion has far-reaching consequences, which involve, amongst other things, that the formation of the yaws lesions on the soles of the feet must depend upon certain other conditions besides infection by the treponema pertenue in the past.

Whether a person who has in the past been infected by the treponema pertenue will react with plantar lesions depends, in part on the chronical trauma, as walking may be called.

An attempt has been made to confirm this conclusion by some more facts:

2. During a tour to the inland region all palmar lesions were described. There were 72 cases, all told.

In 31 cases both hands were affected (possible differences in the seriousness of the lesions on either hand were left out of account).

In 32 cases only the right hand was affected, the left hand being perfectly sound.

In 9 cases the left hand only was affected, the right hand being sound.

All people examined were right-handed. Among the Dyaks in this region the stressing of the hands is very uniform. The only tool these people know is the parang (a chopping knife). This is used for most of their work, e.g. for cutting the trees that have to be removed before a new rice-field can be laid out (cultivation of the soil is out of the question), for cutting the piles used for their dwellings, the siraps (shingles) for their roofs, and for chopping the fire-wood, on which they cook their

food. Only the pounding of the rice is done with both hands, in turn. The circumstance that there are people whose left hands are affected only does not speak against the conclusion that the chronical trauma plays an important role in the formation of the lesions; the skin may show local variations in sensitivity, there may be other predisposing factors, such as fungous infections, etc.

3. A third observation is **the number of palmar lesions as compared with the number of plantar lesions.**
In 240 consecutive cases of palmar and/or plantar lesions the following distribution was noted:

Plantar lesions only:	179
Palmar lesions only	5
Palmar and plantar lesions:	56

Again, only one explanation presents itself: the difference in stress.

4. A fourth observation has already been described on p. 66 (see also Graph. VII and VIII). When the **haemoglobin content** falls **below 70, the percentage of palmar and plantar lesions increases.** This phenomenon also can be explained from a descrease in stress: people with distinct anaemia feel so weak that they do not walk more than is strictly necessary.
From the foregoing it will have become clear that there are many arguments in support of the view that hyperkeratosis (the most important clinical manifestation among palmar and plantar lesions due to yaws) develops in those places of the skin which are exposed to heavy friction. Of much importance is the question whether the lesions develop in those places only. Is it perhaps possible that they arise spontaneously, without there being an apparent cause? Strictly speaking it must be said that this question is difficult to answer. Hyperkeratosis due to yaws may spread beyond the soles of the feet and affect the lower parts of the legs as well. However, also in this case the influence of the chronical trauma can be proved, as will be shown afterwards.
If the lesion occurs on the sole of the foot only it always spreads beyond the normal area of contact between foot and soil. The reason is evident: the feet of people who walk on unmetalled and uneven roads have a much greater area of contact with the soil than the feet of a man walking on a level floor. Consequently the hollow part of the foot is always affected as well, although to a smaller degree than the rest of the sole. Often the lateral sides of the soles show lesions too. When in walking the foot is placed upon the ground, the lateral side is pressed on the soil. For this reason it is the outer side, not the inner one, that often shows a distinct hyperkeratotic lesion.
Particularly on the inner side of the foot small lesions are sometimes observed, outside the area that is exposed to heavy friction. These lesions have a typical appeanrance; they were described as long ago as 1911 by B a e r m a n n. The skin looks as though it were undermined by a small passage. Possibly, these small lesions result from a hard bump against a stone or a piece of wood, or they may be a sign that the affec-

tion is going to spread from the sole across the dorsal of the foot.

All of the facts mentioned above relate to palmar and plantar lesions in adults. However, tables 17 and 18 on p. 25 also refer to young people suffering from such lesions.

When investigating certain phenomena associated with polypapillomatosis in the kampong of Padang the author discovered that, after the generalized infectious stage of the disease had existed for one year, there was always, without any exception, an erythemato-squamous lesion to be observed on the sole of the foot. Sometimes this lesion was formed within a year, but after that period it was sure to be there. This lesion is also found in young people who no longer have papillomatosis.

Even more distinctly than the latter forms this lesion shows that it is generated by friction. It is different from keratodermia — besides in appearance — in that it is easily generated and likewise easily disappears, without a specific treatment being applied. Its localization is subject to wider differences than that of keratodermia.

The lesion was found not only on hands and feet, but also on elbows (school children), on the seat bones, and on the knees and the dorsal part of the feet (in young Malayan women and girls who often rest on their knees). Here aso, the points of friction could always be indicated.

Cases of generalized erythemato-squamous lesions must be called rare. Only once has the author seen a case of this kind, which had resulted from a salversan injection and could hence be ascribed to a Herxheimer reaction. When the treatment was continued, the lesion disappeared.

In my opinion the localized erythemato-squamous lesion may be distingiushed from the variegated picture presented by lesions that may accompany polypapillomatosis. H e r m a n s (1928) is likewise of the opinion that these erythematosquamous lesions should not be considered as residual phenomena of the generalized eruption, but that they are an independent manifestation occurring in the "secondary stage" of the disease. In any case, already during the generalized stage a lesion is observed which conforms to the rule that the chronical trauma has an important influence on certain yaws lesions.

If we restrict ourselves in our conclusion to later forms I think I may say that the occurrence and the localization of hyperkeratosis depend on a chronical trauma: but for this chronical trauma the lesions do not occur.

The seriousness and the duration of the chronical trauma are factors on which the formation of these lesions further depends. A person who walks little does not contract plantar lesions; when the same person, for some reason or other, starts walking much, he develops hyperkeratosis. In my opinion the difference in the frequency of hyperkeratosis between men and women, between the left and right hands, and between hands and feet, should be explained in this way.

It is not only the cronical trauma as such that plays a part in the formation and localization of hyperkeratosis, its seriousness and duration exert an influence as well.

Nodosity and chronic trauma.

In this section the term „juxta-articular nodule" will not be used, not only because it is inconveniently long, but also because it is misleading, as will be explained below.

A yaws nodule is a hard tumour in the subcutaneous tissue; it is round, well-defined, not painful, and it does not ulcerate. These nodules cause little real trouble to the patient, at the worst they may slightly inconvenience him. They react well when a specific therapy is applied, and even the biggest among them mostly disappear after three doses of 1,200,000 U. PAM (procaine penicillin containing 2% aluminium monostearate).

This kind of lesions may be called a distinct late yaws phenomenon. At least, the author noticed them mostly in people older than 35, although he saw some cases of nodules in much younger people, once in a boy of 18. The nodules may occur singly or in groups. Particularly on the coccyx multiple nodules are often found. They generally, although not necessarily, occur in conjunction with palmar and/or plantar lesions.

Inland, where these nodules are very frequent, 50 cases of palmar and/or plantar lesions were counted among 89 people suffering from nodules.

During an examination in which special attention was paid to the occurrence of nodules, 52 nodosity cases were noted on a number of 645 adults (8.1 %). Elsewhere the author found 14 cases among 160 adults (8.7 %). In both places the percentage of people attending the examination was so high that the figures obtained may be called representative. Also in the coastal region nodosity occurs, but only sporadically. Among 279 adults examined, 4 cases were counted (1.4 %).

Nodules are among those yaws lesions about which much is to be found in literature. However, most publications on the subject date back to before 1930, when the aetiologie of the lesion was still uncertain.

In 1899 J a e n s e l m e gave the first description of this kind of lesion, which he called „nodosité juxta-articulair".

In 1904 S c h e i n e r described a number of nodosity cases encountered in the Dutch East Indies, and, although the local population talked of „patek kering" (dry yaws), this investigator did not see any reason for associating the nodules with yaws. In a publication dated 1909 he expressly excluded traumata as a factor in the formation of the nodules, on the strength of a small number of observations.

In 1920 M o n t e l described nodules he had found in Malayans. Often he found the skin over the lesions changed: it showed hyperpigmentation and hyperkeratosis, while in some cases a papillomalike morbid growth was observed as well. He ascribed the lesion to yaws.

Foley and Parrot described some 20 cases (1920) and excluded traumata as a significant factor in the formation of the nodules.

An excellent publication on the subject was written by v a n D i j k e and O u d e n d a l in 1922. These investigators seldom found the lesions in people below the age of 30, and only once in a small child, a boy of eight. They succeeded in establishing, microscopically the presence of

treponemes in the nodules. Soberheim successfully repeated this investigation (1924) and Hu and Frazier succeeded in producing a syphilitic orchitis by means of an extract made from the matter contained in nodules (1932).
In their publication van Dijke and Oudendal do not speak about the possible influence of traumata on the formation of the nodules, but elsewhere, in a discussion of the subject, van Dijke stated that stress is the predisposing factor in this formation.
In 1925 Egyedi described a great number of nodosity cases using the term „bursitis framboesica proliferans".
Dubois and Montcrey (1925) are of the opinion that traumata play an important part.
In the island of Nias, near Sumatra, Genner (1925) found one case of nodosity in every five to ten yaws cases; he, too, ascribed them to traumata.
In a publication dated 1927 Wilkens came to the conclusion that the trauma is an important aetiological factor and in 1928 the same conclusion was reached by Hermans.
After 1930 the nodules were definitively recognized as a phenomenon of treponematosis, although it is admitted that there may occur nodules that are associated with other diseases and clinically indistinguishable from yaws nodules.

The incidence of yaws nodules shows wide variations:

NapalChandra (1930) found 1.5 % cases of nodules in 269 people suffering from yaws;

Dubois (1925): 1-2% of the adult population;

Arnaud (1931): 0.7 % of the adult population;

Blacklock (1929): 1-0.3 % of the adult population;

Breyer, Elsbach, Hermans (1936) examined 1400 Madurese and Javanese. They found 2.2 % cases in the former and 0.7 % in the latter group;

Hewer (1934): 1.6 % of the adult population;

Harley (1933): 6.2 % of 5597 people suffering from yaws;

Wilson (1933): 4.4 % of 424 people suffering from yaws;

Turner c.s. (1934): 0.47 % of 1500 yaws patients;

Van Dijke and Oudendal (1922): 2.3 % of 1557 yaws patients.

In the regions examined by the author nodosity is of much greater frequency than in the cases listed above. 8.1 to 8.7% of the adult population in the inland region had these lesions, and about 35 % of the adult yaws patients were affected.

The location of the nodules is the most typical and most distinct indication that the late forms of yaws (at least a large part of them) are caused by traumata.
The nodules develop in places where a thin part of the skin covers a

more or less prominent bony process, provided such a place is exposed to prolonged stress *).
All of the locations mentioned in literature conform to this description. Van Dijke and Oudendal (1922) cite as places where nodules occur most frequently: elbow, ankles and dorsa of feet, trochanter, knee, patella, tail bone, os ischii, acromion. Bernard (1927) mentions: elbow, knee, trochanter, outer malleolus, tuberositas tibiae, capitulum fibulae, dorsum of finger.
The points at which nodules mostly develop in the population of the Ketapang inland are:

(a) on the foot: capitulum of the metatarsal V; prominent edge of the articulus calcaneo-cuboides;
(b) on the knee: condylus lateralis and medialis tibiae; capitulum fibulae;
(c) on the hip: trochanter majus;
(d) the lower sacral vertebrae and the coccyx;
(e) the elbow.

The author has never observed nodules in places other than those mentioned above.
This invariable localisation can only be found in a population the members of which show a far-reaching uniformity in living habits.
In order to understand why the nodules have a particular location it is necessary for us to have a good knowledge of the living habits of the population.
Some of the locations mentioned above demand a further explanation, in particular those on the feet. The nodules on the outside of the dorsa of the foot are due to a particular way of sitting. The most important sitting habits in the district of Keapang are: sitting with crossed legs, kneeling and squatting. The first way of sitting is mostly observed among men, sometimes in Dyak women. The second way is generally practiced by women; the third does not play a part in the formation of nodules.
When a man is sitting with his legs crossed, the lateral part of the dorsa of the feet lies flat on the ground. In people who habitually sit in this way the movability of the joints of Lisfranc and Chopart is much greater than in people who wear footgear and usually sit on chairs. In a man sitting with his legs crossed the pressure is taken by the base of the metatarsal V, but in particular by the capitulum of the metatarsal V, by the slightly prominent part of the joint between cuboid and calcaneus, and by the malleolus lateralis. One leg is supported by the foot of the other and thus increase the pressure exerted on this foot. However, the pressure on the dorsum of the foot is determined not only by the weight of this foot itself plus that of the leg resting on it, but also by part of the weight of the trunk. For, if the trunk were not

*) The nodules bear no relation whatever to joints, although it is true, of course, that the „more or less prominent bony processes" are mostly found near the joints.

inclined forward, it would be in a labile position, so that sitting would become impossible. Therefore, the body is bent slightly forward and the balance is preserved by the tension of the dorsal muscles on the one side and the weight of the body bending forward on the other, which weight is borne by the dorsum of the supporting foot.
Finally, the weight of the arms heightens the pressure exerted on the dorsa of the feet, as the arms are mostly rested on the knees. All in all, a respectable weight is to be borne by the feet.
In the second way of sitting, kneeling, which is only practiced by women, the trunk is mostly placed to the right or left of the legs, so that the greater part of the body's weight presses on the lower part of one leg. In this case the stressed points on the dorsum of the foot are the same as mentioned above for sitting with crossed legs, namely: the base of the metatarsal V, the capitulum of the metatarsal V, the prominent part of the joint between cuboid and calcaneus, and the lateral malleolus. In addition, there is a pressure acting on the condylus lateralis tibiae of the supporting leg, and on the condylus medialis tibiae of the foremost leg. The pressure on the two condyles depends on the individual's way of sitting, and further on the development of the sural muscles. The stress on the condylus medialis of the foremost leg is greater than will be expected at first sight. In order that the balance may be kept, the body is inclined sidewards, to the side of this foremost leg. Now the balance is preserved by the tension of the muscles of the trunk on the one side, and the weight of the trunk on the other, which weight is taken by the condylus medialis of the foremost leg.
Both in sitting with crossed legs and in kneeling, the posture of the body is changed from time to time, so that the dorsa of both feet and the lower parts of both legs are stressed. In both ways of sitting the greatest stress is exerted on the lateral malleolus and on the joint between calcaneus and cuboid. Therefore, these are the places where the greatest numbers of nodules are found. Sometimes the elbow is stressed in sitting, while in sleeping the lower part of the sacrum, and the trochanters and fibulae are stressed.
As was shown above (page 71), plantar lesions are considerably more frequent among men than among women. This is to be ascribed to the fact that men walk much more than women. As now, women sit more than men, cases of nodosity must be expected to be more frequent among women than among men. In the following we will check whether this expectation is justified.

During one of his tours the author found the following:
in 857 men there were 35 cases of nodosity (4.1 %);
in 688 women there were 54 cases of nodosity (7.8 %).

Some figures referring to the kampongs of Tandjung Djelei, Pessangeran, Silat, Pering Kunjit, Riam Kusik and Penjiruan are more reliable, as in these kampongs almost the entire population attended the examinations. Here the author found:
in 399 men: 29 cases of nodosity = 7.3 % (21.1 %);
in 406 women: 38 cases of nodosity = 9.4 % (10.0 %).

The percentages given in brackets refer to palmar and plantar lesions. It should be noted that, whereas for men the fequency of plantar lesions is nearly three times as high as the frequency of nodosity, for women the respective percentages are almost equal. Although the difference between the percentages in the two cases under discussion (4.1-men and 7.8-women, and 7.3-men and 9.4-women, for the first and second groups, respectively cannot be called great, I yet think it is significant, especially if it is borne in mind that sleeping as a factor of fressure is of equal importance for both men and women.

Among the hundreds of cases of nodosity which the author has noted, there was not a single one in which the nodules had developed in places other than those mentioned above.

It need hardly be said that in other regions, where the population has living habits differing from those met with in Ketapang, the nodules must be expected to form in other places. As an example we may take the nodules on the patella, illustrated in M a n s o n - B a h r ' s manual on tropical diseases. This location would be impossible in the district of Ketapang, as the population there does not work in a kneeled posture.

Judging by the publications on the subject it must be thought possible for nodules to form in places not subject to external traumata. Such cases are rare in practice, and this might be the reason why there are so often dealt with in literature. Moreover, such an a-typical location might result from the pressure exerted by sinews and muscles connected to the bones. In places where the skin is sensitive such pressure might result in the formation of nodules.

E gy e d i (1925) speaks about a „bursitis framboesica proliferans". The word „bursitis" does not seem a felicitous choice, as, clinically, no inflammation is ever noted, but the association with a bursa is, to the author's mind, pretty obvious.

Therefore, there is every reason to call nodosity the most typical manifestation of the influence of external traumata on late forms of yaws.

In places where, in a normal skin, a bursa is apt to form, a nodule may develop in a yaws patient. The mere presence of a mechanical trauma cannot, in itself, be called the cause of the formation of nodules: evidently, the nature of the trauma is determinative of the nature of the resulting lesion.

Whereas friction causes callosity, and pressure a bursa in a normal skin, the skin of a yaws patient may react to such traumata with hyperkeratosis and nodules, respectively.

Hyperpigmentary „pintoid" forms of yaws and chronic traumata.

All late manifestations of yaws may be said to be no specific lesions. Hyperkeratosis, nodules, ulcerations, periostitis, arthritis, are encountered in connection with all kinds of other diseases, in the first place with all other forms of treponematosis.

Yet, plantar lesions and nodules occurring in a region like Ketapang do not cause difficulties in the diagnosis. The picture they present is well-

defined, and in practice diagnoses other than yaws are not eligible in this region.
However, it is quite different with the pigment shiftings frequently met with in the district of Ketapang. These shiftings are encountered not only in connection with other treponematoses, but also with numerous lesions of a totally different nature. In this case diagnosing is extremely difficult.
There are hyperpigmentations that are easy to diagnose, however. These are referred to as „pintoid forms" and there occur yaws lesions in the Ketapang inland which the author, in as far as he is aquainted with Pinta from literature, cannot distinguish from the last stage of pinta.
In articles and manuals little attention has been given to this kind of lesions. Manson-Bahr (1948) briefly stated that leukodermia occurs in connection with yaws.
An interesting description of the fungus „tinea albigena" was given by Nieuwenhuis (1904). In Borneo this investigator found hyperpigmentary skin lesions which are obviously identical with those of which the present part of this study is to treat.
Baermann (1911) doubted if lesions as described by Nieuwenhuis were to be ascribed to fungous infections, and associated them with yaws.
In 1949 Simmons devoted an article to tinea albigena, in which he called the lesion described by Nieuwenhuis „Asiatic pinta".
Also for another reason the mistake made by Nieuwenhuis is interesting: up to 1938 pinta was considered to be a fungeous disease. Only in that year did Armenteros, Triana and Blanco discovered the treponeme.
Hyperpigmentary and depigmentary manifestations of yaws and pinta appear to be seen in conjunction with fungeous infections so often that one is inclined to wonder if, after all, there is a certain relationship between the fungous infections and the pintoid manifestations, although they are now generally distinguished from each other.

In 1925 Heerdjan described what he called „a particular form of yaws III", manifesting itself in: (1) diffuse hyperkeratosis; (2) a hyperpigmented centre; (3) depigmented edges: (4) sharp limitation. In 1928 Hermans remarked, referring to this publication, that there is no reason to speak of a new form, as there is, actually, no difference between keratodermia and the lesions described by Heerdjan.
As a matter of fact the lesion referred to as „pintoid form" is not characterized only by a shifting of the pigment. Although there are cases where the only manifestations are hyperpigmentation and depigmentation, generally other lesions are found as well, in particular hyperkeratosis.
Pigment shiftings are frequently seen to accompany yaws. They are observed in connection with the earliest stages as well as with a number of later manifestations of this disease. In addition, the scars left by both superficial and deep yaws ulcerations nearly always

comprise depigmented parts of skin.
However, the manifestation to be dealt with here is not associated with ulcerations, lupoid forms, etc. It is a hyperpigmentation by itself, which may, in course of time, lead to complete (vitiligo-like) depigmentation. It is a decidedly late manifestation of yaws — a lesion occurring in old people —, often, although not necessarily, found combined with palmar and/or plantar lesions and nodules.
One of the characteristics by which this yaws lesion distinctly differs from pinta is its late occurence: in pinta patients pigment shiftings may occur at a very early age.
The pintoid form under discussion here is found mainly on the extremities. It consists of small brown, blue and black hyperpigmented spots, ranging in number from a few to a large amount. These spots, each of which measures at the most 1/5 in. in diameter, are usually follicularly arranged. Sometimes, completely depigmented spots are to be found as well. The picture these lesions present is of a mottled appearance, at least in the first stage of the disease.
After the process has had its course in one place, it sets in, in another, and in this way a large part of the skin on the extremities may become depigmented in course of time, while sometimes small isolated spots of normal skin are left among the places attacked by the disease.
This hyperpigmentary form of yaws does not invariably show a follicular pattern; sometimes a relatively large part of the skin is seen to be uniformly slate-blue, with small depigmented spots developing in the blue patch.
Often, the patients complain of itch, although this need not be so in all cases. If the lesion does cause itch, however, it may become erythematous in appearance, and get mixed with symptoms caused by scratching.
As already stated above, the lesions are often found combined with tinea imbricata. The latter disease is particularly frequent in the northern part of the inland region. On the coast it is of rare occurence. It is restricted to a limited number of families, as the male sufferers from tinea imbricata are allowed to marry only their female fellow-sufferers. Consequently, the children born in such a family are infected at a very young age. In Dutch, tinea imbricata is called „Dajase schurft" (Dyak scabies), in Indonesian its designation is „kurab" (the latter is, however, a collective name given to all kinds of fungous diseases). If tinea imbricata occurs in combination with a hyperpigmentary yaws lesion, the Dyaks of this region speak of „kurab besi" (iron scabies)*), or sometimes of „kadal", although the latter term is mostly used to refer to the hyperpigmentary form by itself.
During a tour along the upper raches of the river Lauer the author examined 366 adults, inhabitants of the villages of Entinap, Kepari, Semapau Hulu, Tandjung Beringin and Selangkut. The total number

*) The term „kurab besi" is quite appropriate, it is descriptive of the appearance of the lesions. The term is known also in other places within the Indonesian archipelago, but seems to have a completely different meaning there.

of adults living in these kampongs was 419, so that the attendance at the examinations is to be put at 87.5 %. Of the 366 people examined, 47 proved to have tinea imbricata (13 %), among which 14 suffered from hyperpigmentary lesions.

TABLE 44.

Data on pintoid forms collected during a tour along the upper reaches of the river Lauer.

Adult population	419
Number of adults examined	366
Attendance percentage	87.5
Number of yaws cases	87
Frequency percentage of yaws	23.8
Number of sufferers from hyperpigmentary forms	20
Ditto, combined with plantar lesions	14
Number of sufferers from tinea imbricata	47
Number of sufferers from tinea imbricata + hyperpigmentation	14
Number of sufferers from hyperpigmentary forms only	2
Number of sufferers from hyperpigmentation as a percentage of the number of persons examined	5.5
Percentage of people suffering from tinea imbricata + hyperpigmentation, in relation to the total number of sufferers from tinea imbricata	30.—

From this table it is seen very clearly that people suffering from tinea imbricata show a distinct predisposition for the „pintoid form".
The hyperpigmentary lesions occur exclusively on the extremities, with perhalps a very rare exception. They are found in particular on the hands and forearms, and on the feet and the lower parts of the legs. Distinct sites of predilection are the anterior part of the lower leg and the dorsum of the foot and the hand, and the dorsal part of the forearm.
Some further preferred locations are: the elongation of the palm of the hand, i.e. the distal part of the forearm, and a zone around the lips.

There are numerous arguments in support of the view that these pintoid yaws lesions are due to a chronic trauma. The Dyak of this region certainly does not take the trouble to build good roads. Only those trees and shrubs which are directly in his way are cut down. As a result, legs and arms of a walking person are constantly irritated by branches, twigs, grasses, etc. Anybody used to walking in the jungle will agree that it is absolutely impossible to cover a few miles without getting a number of scratches. If one further remembers that the average Dyak walks much, one will no doubt be able to appreciate that such a light trauma, persisting through several decades, may eventually become serious.
In the author's opinion the crhonic trauma is an important factor in the formation of yaws lesions of a hyperpigmentary character. The weightiest arguments in support of this view are:

1. Practically the only parts of the skin affected are those which are canstantly exposed to this trauma.
2. The lesions are seldom met with in regions where the scenery and the living habits of the population do not give rise to the trauma. At least, the author saw the pintoid forms only seldom south of Ketpang on the coast; in the rare cases in which he did observe them in this region they were always restricted to hands and feet. Vegetation and living habits there gave no rise to the formation of the lesions under discussion.

In addition to this trauma, the chronic irritation to which the skin is exposed, there is the sometimes itchy character of the lesions. The frequent scratching due to this will not only keep the lesions alive but may also make them spread. This gives rise to the presumption that there exists a certain connection between hyperpigmentary yaws lesions and tinea imbricata, which is often seen to accompany these lesions. This disease is just as itchy as any other fungous disease, and it is quite understandable that the Dyak suffering from it scratches frequently and long, in the places which first present themselves: the forearms and the lower parts of the legs. (It should be remembered that in sitting with his legs crossed a person generally rests his arms on the lower parts of the legs or on the knees, and further that the dorsum of the hand and the forearm form the most obvious places for thoughless scratching). Hyperpigmentation around the lips is only seldom met with. The author observed the lesion in this location only nine or ten times, in sirih- (betel quid) chewing old women. These persons were in the habit of scraping their upper and lower lips with their teeth. In the author's opinion this scraping was responsible for the ring of hyperpigmentation observed around the lips, the extent of which ring exactly corresponded with the area covered by the scraping teeth.
The above description, which is as accurate and complete as possible, is the strongest evidence the author has been able to find in support of the view that in yaws patients chronic irritation of the skin may give rise to hyperpigmentation. Seen in conjunction with the whole set of factors, the role played by this irritation seemed so important that reference to the facts appeared in every way justified.

Chronic trauma and other non-contagious yaws lesions.

The non-contagious forms of yaws dealt with so far are: erythematous-squamous lesions, palmar and plantar lesions, nodules and hyperpigmentation.
Although any of these forms may well be found by itself, it may also occur in combination with one or more of the others, or with yet other late skin lesions due to yaws. Between the scaly erythema — which may be called the earliest — and hyperpigmentation — which may be called the last non-contagious skin lesion due to yaws — there is a whole range of skin lesions which may be strongly intermixed, so that an ever varying picture is presented by the non-contagious yaws lesions of the skin.

It is by no means the author's intention to give a clinical description of these skin lesions, as this would carry us beyond the scope of this publication. Yet it is necessary to devote some words to this subject, as the influence of a chronic trauma can often be observed in lesions other than those discussed above. The eleven cases described below may serve in evidence. The descriptions are restricted to morphological phenomena and are meant to throw some light on the typical locations of the lesions.
The most important manifestations mentioned in connection with the cases described below are:

1. the erythema, scaly or non-scaly;
2. papules;
3. hyperkeratosis;
4. nodules;
5. superficial and deep ulcerations;
6. periostitis;
7. hyperpigmentation.

To these may be added a coarsening of the skin relief and, as a subjective phenomenon, itching. Sometimes, the skin shows infiltration at the spot where a lesion is located, in other cases this infiltration is absent or not discernible. The cases described below were, all of them, treated and checked, so that eventually the diagnoses were confirmed ex juvantibus. Most of the observations were made in the kampong of Padang, in December 1952 and January 1953.

CASE NO. 1.

Mat Arib, male, age 46, inhabitant of Padang.
As a child he had had papillomatosis, the scars of which were still visible. At the time of examination he had been suffering from plantar lesions for 8 years.
Hands: only the right hand was affected, the left hand being perfectly sound. The dorsum of the right hand had lost part of its relief, it was smooth and showed a few totally depigmented spots. The left-hand dorsum was quite normal. The nails were sound.
On the volar side of the right forearm, in the elongation of the hyperkeratotic lesions, part of the skin was depigmented, and further up the forearm there was a patch of hyperpigmentation. The latter lesion was itchy.
Feet: both soles showed hyperkeratosis. On the malleolus fibularis dexter there was a scaly patch, surrounded by a ring of hyperpigmentation. The surface of the dorsa were slightly erythematous, with some hyperpigmented spots. The lesions on the dorsa were itchy.
Left thigh: at the spot where, in sitting, the skin is stressed by the ischium there was a round patch, the centre of which was livid and slightly scaly. Surrounding this was a, not quite complete, slightly depigmented ring. The lesion was itchy.
There were no skin lesions in other locations.
All the phenomena disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 2.

Mohammed Taha, male, age 60, inhabitant of Padang. When a child, he had had papillomatosis. At the time of examination he had had plantar lesions for four years.
Hands: only the right palm was affected. On the right forearm, in the elongation of the hyperkeratosis on the palm, there was a hyperpigmented patch, about 6 in.

in lenght, with some eroded spots. Surrounding this was an incomplete zone of depigmentation.
Feet: both soles showed the typical plantar lesions. The skin on the dorsa and on the legs, below the knees, was scaly, especially at the front, and showed some hyperpigmented as well as a few depigmented spots.
All of the lesions, with the exception of the depigmentation, of course, disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 3.
Dadaong, male, age 39, inhabitant of Padang, a tailor. As a child he had had papillomatosis.
The hands were completely sound.
The soles of both feet were hyperkeratotic; the skin of the outside of the dorsa showed strong coarsening.
On the nates, exactly on the seat bones, there were two erythematous-squamous lesions, which were not itchy.
The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 4.
Talaha, female, age 13, inhabitant of Padang. As a child of seven she had had papillomatosis, against which she had received one salversan injection. At a later age she had suffered from localized papillomata on the soles of the feet, against which a further salversan injection had been given.
On the condylus tibialis tibiae sinistra the author noted a patch, about 2 in. by 1 in., of a cyanotic colour, which was infiltrated and which slightly projected from the skin surface. In this patch there were a few papules and some superficially eroded spots. Near by there was an incompletely depigmented scaly patch.
A similar lesion was found on the lateral part of the left leg, 2 in. above the maleolus fibularis. It was found that, when the patient knelt dwon, the two points were distinctly stressed: the left tibial condyle when the legs were stretched to the right, and the lateral part of the lower leg when the legs were stretched to the left. The girl was accustomed to take up both postures in turn. In addition there was a slight, painful, thickening of the bone at the front of the right tibia.
The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 5.
Amnah, female, age 48, inhabitant of Padang. As a child of about 5, she had had papillomatosis. In the examination the author noted lesions on the soles of both feet; on the outside of each dorsum there was an erythematous-squamous lesion. These lesions were itchy. The spots were stressed in sitting. The places of the dorsa not stressed, and the median sides of the dorsa, were completely sound.
The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 6.
Muhamad, male, age 35, inhabitant of Padang. As a child of ten he had had papillomatosis. The author found the soles of both feet hyperkeratosis. The skin on the dorsal parts of the feet and on the lower parts of the legs, halfway up the tibiae, was scaly and showed diffuse hyperpigmentation, with some completely depigmented spots. The lesions were itchy and the patient spontaneously declared them to have been caused by much walking in high grass. They disappeared (with the exception of the depigmentation) after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 7.
Senintan, female, age 11, inhabitant of Padang. At the age of seven the girl had suffered from papillomatosis. On the bridge of the nose there was an erythema. In addition there were two small papulous spots, one on the dorsum of the left hand, the other on the fibular condyle of the tibia sinistra. These spots were lichenified and erythematous. The lesions were itchy.
The location of the erythema on the bridge of the nose cannot be explained by the author.

The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 8.

Maimunah, female, age 19, inhabitant of Padang. At the age of seven she had had papillomatosis.
At the time of the examination there were hyperkeratotic lesions on the sole of the right foot. On the dorsum of the left foot and on the lower par of the left leg there were two large hyperpigmented patches with some papules and excoriations. The lesions were itchy; they were located in places stressed in sitting but were slightly more extensive than the zones of pressure.
After injection of two doses of 1.200.000 U. P.A.M. the lesions disappeared.

CASE NO. 9.

Akram, male, age 49, inhabitant of Ketapang. As a child he had had papillomatosis. At the time of examination he had suffered for three years from hyperkeratotic lesions on both hands and both feet. All the nails of the hands showed strong thickening, whereas those of the feet were normal.
On the dorsa of both hands and feet there were lichenified erythematous-squamous lesions.
On each of the nates, exactly on the seat bone, there was an erythematous squamous lesion. These lesions were linked up by a strip, about 2 in. wide, across the lower part of the sacrum. The region around the anus was not affected.
The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M. The nails, however, still had the same appearance two months after the treatment. At that time the soles of the feet still looked slightly scaly, but the typical stiffness had gone. The skin was as supple as that of a normal sole.

CASE NO. 10.

Mohamad, male, age 40, a tailor, inhabitant of Ketapang. As a child he had had papillomatosis.
His hands were perfectly sound, whereas the soles of his feet were slightly hyperkeratotic. The lateral sides of the dorsa of the feet were a livid blue and were strongly lichenified. The skin was not scaly, however.
On the left malleolus lateralis and os cuboides there were two small nodules, on which the hyperpigmentation was most distinct.
Two erythematous squamous patches were observed over the two tubera ischiadica (cf. description of case No. 3).
The lesions disappeared after injection of two doses of 1.200.000 U. P.A.M.

CASE NO. 11.

Fatima, female, age 35, inhabitant of Sg. Besar.
Gummata were observed in various locations, as well as ulcerations and scars left by previous large ulcerations.
The lesions had started on the lateral side of the dorsum of the left foot, and on the left elbow, near the olecranon. Some time afterwards a gumma had developed on the right median ankle and another on the lateral condyle of the left tibia.
In this case the lesions started, as is seen, practically on all points stressed when the patient knelt down and stretched her legs to the right. Even the median malleolus was affected, although it is never seriously stressed.
Because of the lesions, the patient had to stretch her legs to the left in sitting, in consequence of which there appeared a gumma on the lateral side of the dorsum of the right foot, and another on the right elbow. On the os zygomaticum dexter there was a scar, resulting from an ulceration (presumably caused by resting on the arm during the sleep). At the front of the right tibia there was a — not very extensive — periostitic zone.

The open wounds closed after three injections of 1.200.000 U. P.A.M.

The joint influence of chronic trauma and state of health on the formation of late yaws lesions.

1. The ultimate cause of any yaws lesion is the presence of the treponema pertenue in the human body. Wheter a late form of the disease can develop and, if so, which, depends on the „changed tissue-reaction" arising from the prolonged presence of the treponema in the body.
2. Hyperkeratosis, nodosity and hyperpigmentation can become manifest only as a result of the action of a chronic trauma. Arguments in support of this supposition are numerous, those speaking against it only few.
3. The influence exerted by a low haemoglobin content, periodic re-infection by malaria parasites, poor food, and ankylostomiasis are essentially different: they facilitate the formation of the lesions, but are not essential to it, whereas the chronic trauma is.
4. There are indications that the state of health may have an influence on the nature of late manifestations.
5. The significance of the chronic trauma may be specified as follows:

(a) **The location of late skin lesions,** or at least of the majority of them, is determined by the chronic trauma. In exceptional cases, however, instances may be encountered in which this rule does not apply.
Mass examinations have brought the author to attach so much value to this rule that in his opinion there is reason for seriously doubting a yaws diagnosis in cases where the location of the lesions is fully a-typical. Anybody who should want to use this differential characteristic for purposes of diagnosis should bear in mind that he has to be very well aquainted with the living habits of the population of the region where he makes his investigations.

(b) **The nature of the chronic trauma** has an influence on **the nature of lesions.** Whereas the reaction to friction of a normal skin is the formation of a callous spot, the skin of a yaws patient may react with hyperkeratosis; whereas in a normal subcutis prolonged pressure will result in the formation of a bursa, the skin of a yaws patient may under similar conditions develop a nodule; and whereas chronic irritation need not cause any reaction at all in a normal skin, the skin of a yaws patient may react with hyperpigmentation. These remarks are, of course, somewhat „schematic", for irritation is unimaginable without friction, and pressure always implies irritation. Consequently, the skin over a nodule is often found changed, as M o n t e l already described in 1920 (p. 74), plantar lesions are mostly accompanied by hyperpigmentation and loss of pigment, and hyperpigmentation on arms and legs is often seen in combination with hyperkeratosis. Yet, the above differentiation is certainly justified. It is most marked in the difference in the reactions to pressure and friction.

(c) **The seriousness and the duration of the trauma** also influence the formation of the lesions. Whereas a light trauma may not cause lesions, a serious and prolonged trauma will do so.

Remaining to be discussed are points C and D of page 58.

C. Is it possible that **differences between the treponema pertenue strains** account for the difference between the inland and coastal regions as regards the relative frequency of palmar and plantar lesions? The possibility of a difference between the strains of the treponeme found inland and in the coastal region has already been dealt with on p. 34. After the infection by the treponeme changes occur in the organism of yaws patients which manifest themselves in the various lesions to be observed in the course of the disease.

Whether a particular strain of treponemes produces a particular change in the human organism — i.e. whether the treponeme occurring inland predisposes people to contract plantar lesions, and the strain found in the coastal region does not, or whether the coastal treponeme develops a high degree of immunity against later forms of yaws in the human body, and the inland strain does not — is a question that is very difficult to answer, but the possibility of this being so should always be borne in mind.

D. Are there any **differences** between the inland and coastal regions **as regards the course of the disease,** and is it possible that such differences account for the difference in the frequency of plantar lesions between the two regions?

In Chapter V it has been set forth that differences as meant here actually exist.

Inland, generalized papillomatosis is relatively much less frequent than in the coastal region. This finds its explanation in the fact that inland the duration of papillomatosis is, on an average, shorter than in the coastal region.

Could there be a correlation between the mean duration of papillomatosis and the frequency of occurence of later manifestations? This is generally believed to be the case with syphilis. In 1949 T h o m a s stated, in a book on the course of syphilis and the treatment of this disease:

„The suggestion has been made that the more extensive and pronounced the reaction of the skin during the secondary syphilis, the more immunity is developed to late manifestations of the disease, especially in the central nervous system. In other words, marked secondary reactions of the skin are believed by many observers to result in an increased ability of ectodermal tissues to resist the infections".

In this thesis (1928) on „Framboesia tropica", Hermans states on p. 150:

„.....but yet I want to point out here that also about lues it is known that a light or unnoticeable first or second sage predisposes the sufferer to develop tertiary and metasyphilitic manifestations, whereas among those peoples in which skin localization is as a rule very pronounced, the further course of syphilis is, in general, rather harmless."

A second remarkable phenomenon, which may certainly not remain unmentioned in this conection, is the popular belief, met with all over the world, that papillomatosis must not be treated medically before the papillomes have existed for a considerable time and have been

fairly numerous. It is said to be harmful to attack papillomatosis in an early stage; people in regions where yaws is endemic are very staunch in this belief (cf. Hill, 1953).

It is highly improbable that this belief should have arisen only after the discovery of salversan. The opinion is too general and too widespread for it to have been formed in so short a time.

Indeed, this view was expressed already before salversan was known. By the end of the 18th century Schilling stated that the initial stage of yaws was determinative of the further course of he disease. In cases where he number of eruptions was only small, he predicted much trouble and difficulties for the sufferer afterwards. In 1928 Hermans, in a chapter entitled „Popular healing art and popular beliefs", cited several authors who are of the same opinion.

The fact that people are unwilling to receive medical treatment when the disease is in its initial stage should consequently not be ascribed to fear of frequent recidivation after an (inadequate) salversan treatment, but rather to a certain anxiety that, in view of the future, the duration of the illness has been too short to justify treatment (cf. Hill, 1953).

Furthermore, it is generally believed to be best for children to get infected at a very early age; it is said that in this case they stand the best chance to be spared the unpleasant results of the disease at an older age (cf. Hermans, 1928; Hill, 1953).

These popular beliefs, and the opinions cited about the influence of duration and seriousness of the generalized lues eruption on the further course of this disease, are in striking agreement with the facts the author has noted in connection with yaws endemics in the inland and coastal regions of the district of Ketapang:

(a) The age at which infection occurs in the coastal region is very low, distincly lower than inland;
(b) he duration of the papillomatosis stage is believed to be much longer in the coastal region than inland.

It is, therefore, to be expected that the number of late manifestations will be much smaller in the coastal than in the inland region. This expectation is confirmed by the facts as the author found them, by the citations about lues given above, and by the popular belief which has just been described.

However, it is difficult to prove the existence of a relationship between the mean duration of papillomatosis and the frequency of later yaws manifestations. To produce such proof, the population of an area would have to be observed for at least 30—40 years, without ever receiving treatment.

Still, there is every reason to suppose that the seriousness and the duration of papillomatosis have a great influence on the further course of yaws, in such a way that **the frequence of late manifestations decreases as the mean duration of the papillomatosis stage increases.**

This hypothesis fits in very well with the general opinion on the early treatment of other infectious diseases.

An early suppressive treatment of malaria, e.g. — not resulting in permanent recovery — will sooner lead to recidivation than a treatment started after a number of malaria attacks have taken place.
A similar phenomenon is to be observed in the case of typhus adbominalis, now that modern chemotherapeutics enable the physician to win an easy triumph over the illness. An early treatment with a minimum dose of therapeutic prevents the development of complete immunity and leads to recidivation.
With yaws as well as with malaria and typhus abdominalis the degree of immunity is supposedly dependent on the number of pathogenic germs destructed. An early suppressive treatment will strongly reduce the number of germs and thus prevent the development of a high degree of immunity.
A protacted or violent papillomatosis stage warrants the destruction of a large number of treponemes, in consequence of which a high degree of immunity will be obtained.
In the author's opinion this hypothesis forms the keystone to and, perhaps, the most important factor in the solution of the problem posed at the beginning of this study.

CHAPTER VII.

COMPARISON OF THE YAWS ENDEMICS OF INLAND AND COASTAL REGIONS.

In view of all that has been said about the factors involved in the formation of yaws endemics, and about the various forms in which an endemic of this kind may manifest itself, it will be clear that an attempt to account for the differences between the endemics of the coastal and inland regions is far from easy.

The first difficulty is encountered in the comparison of papillomatosis as it is found in the two regions; next there are the differences in the immunity development, and finally the matter is made more complicated still by the influences exerted on the development of late manifestations.

Therefore, the author has no illusions about the possibility of giving a full explanation of all the differences which exist between the yaws endemics of the coastal and inland regions. Many questions will have to remain unanswered.

It would be absurd to expect otherwise. An endemic is a biological phenomenon, which, like other phenomena of this kind, can only in part be expressed by statistical means. As the way in which an illness develops in a human body is dependent on the patient's physical constitution, so the way in which an endemic manifests itself will be dependent on the general physical constitution of the population it affects and on the conditions under which this population lives.

All comparisons made so far related to individuals living together in small village communities. All the external and accidental conditions involved may therefore be called uniform. The living habits of these people show so little variation that no difficulties need be feared on this account. This is the reason why the statistical data concerning the relationship between splenic enlargement and haemoglobin content on the one hand and plantar lesions on the other show such a regular pattern as they do. If, in the village in which the examinations were carried out, there had been question of a serious state of malnutrition of the population or of part of it, this factor would probably have rendered the relationship between the state of health and the occurrence of plantar lesions so involved that it is to be doubted whether our investigation concerning the plantar lesions could have been carried out at all.

In order not to pass directly from a comparison of individual persons, as given in the preceding chapters, to a comparison of the two regions in which examinations were made, the inland and the coastal region, the author has tried first to compare a number of inland kampongs. In this way he hopes to demonstrate, by means of a simple example, that comparisons between groups of people are fraught with many difficulties.

The kampongs referred to in this connection are identical with those mentioned in Chapter VI, which deals with the relationship that exists between splenomegaly and haemoglobin content on the one hand and the occurence of plantar lesions on the other. This comparison is relatively easy to make, since it may be assumed that:
there are no significant difficulties of epidemiological nature, and there are no very wide differences in living habits and in the general state of health between the kampongs.
The kampongs have been classed into three groups:
Group 1 — Tandjung Djelei, the best Dyak kampong of the Ketapang inland as regards general sanitary conditions;
Group 2 — This group comprises the Dyak kampongs of Pering Kunjit, Pessangeran and Pendengeran, villages which, it is true, have some contact with the outside world, but are very much more primitive than Tandjung Djelei;
Group 3 — Silat, the only Malayan kampong in which attendance was sufficiently high to enable the results of the examination to be used in this study.
Of the various yaws lesions only the palmar and plantar lesions are eligible for purposes of comparison. Papillomatosis cases are so small in number (fewer than 30 for all groups together) that comparison is not justified.

TABLE 45

Mean haemoglobin content, percentage of splenomegaly, and percentage of plantar lesions in men and women of the three groups of kampongs. (Percentages are calculated in relation to the total numbers of men and women examined).

	Mean haemoglobin contents		Splenomegaly, percentages		Palmar and plantar lesions, percentages	
	Men	Women	Men	Women	Men	Women
Group 1	81.1	79.2	38	41	39	26
Group 2	76.7	75.9	51	52	54	43
Group 3	72.4	71.1	42	39	39	13

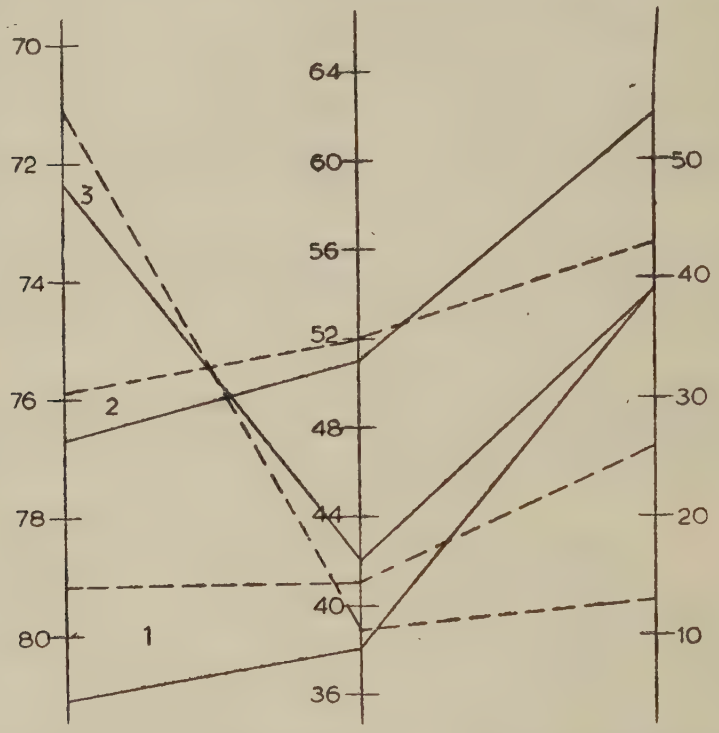
The question is whether it is possible by means of the figures for haemoglobin content and splenomegaly to account for the differences in the frequency of palmar and plantar lesions. And, if these figures by themselves should not suffice to give a complete explanation, what other factors should be considered as having an influence?
It should once more be pointed out that equal parts of the populations of the various groups of kampongs are assumed to have been infected. For the sake of convenience the figures are given in a graph, No. X, demonstrating the relationship between splenomegaly and haemoglobin content on the one hand and the occurence of plantar lesions on the other.
As the percentage of plantar lesions rises in proportion as the haemoglobin content falls off and the splenomegaly percentage increases, the scale for the mean haemoglobin content gives a decrease in value from

the bottom to the top of the graph, whereas the scale showing the percentage of splenomegaly shows an increase in this direction. Otherwise, the scales are plotted arbitrarily against each other, as the graph is only intended to show the figures in a more readily understandable form.

GRAPH No. X.

(Explanation is given in the above text).

The figures 1, 2 and 3 correspond to the groups of kampongs mentioned above.



(a) — The lines plotted for groups 1 and 2 clearly show a correspondence. For these two groups practically all factors influencing the occurrence of the lesions (epidemiological factors, environmental factors, walking, nutrition, etc.), with the exception of haemoglobin content and splenomegaly, are equal. In the author's opinion the latter two factors are the only ones responsible for the fact that the percentage of plantar lesions is considerably higher in group 2 than it is in group 1. It should further be noticed that for the women belonging to groups 1 and 2 the percentages of plantar lesions are lower than for the men of the same groups, although, for both of the groups, the women's

mean haemoglobin contents as well as their splenomegaly percentages are slightly less favourable than the men's.
This may in part be due to a lower percentage of the women being infected, but doubtless the principal factor is the difference in the mechanical stressing of the feet that exists between men and women.
Judging from the example given above we must conclude that for regions where external conditions, such as malaria, nutrition, chronic trauma, etc., are not so very nearly the same, similar comparisons will be very difficult to make.

(b) — This is immediately realized more clearly when we try to compare groups 1 and 2 with group 3.
The kampong of Silat (in group 3) is Malayan, the others are Dyak. Let us assume that the factors influencing the epidemiology are equal for groups 1, 2 and 3 (there seems, indeed, little reason why this sould not be so). Still, this equality proves to produce no correspondence whatever between the three groups as regards the relationship of haemoglobin content and splenomegaly to plantar lesions. Group 3 clearly differs from the other two in this respect.
In the kampong of group 3 the haemoglobin content is much lower than would be expected from the splenomegaly percentage. Ankenlostomiasis cannot play a significant part here, as in Malayan kampongs sanitary conditions are much better than in Dyak villages (cf. p. 14). Most probably, the cause of the low mean haemoglobin content is the poor nutrition of the Malayan population in the inland region. This difference in nutrition by itself renders it impossible to make a comparison as regards the frequency of palmar lesions between groups 1 and 2 on the one hand and group 3 on the other.
What can be accounted for, however, is the fact that among the Malayan women the percentage of plantar lesions is considerably lower than among the female Dyak population. The average Malayan woman prefers to stay indoors, and certainly walks much less than her Dyak sister.

That there does exist a relationship between splenomegaly and plantar lesions has, in the author's opinion, been clearly demonstrated in Chapter VI. However, this does not imply that the mean splenic index in a particular region or village is an indication of the frequency of plantar lesions. It cannot be maintained that in a region where the mean splenic index is high more plantar lesions must necessarily be found than in a region where this index is low — not even if the epidemiological factors are the same for the two regions.
For instance, in a group of 284 adult Malayans, 20.4 % were found to have plantar lesions, whereas, in the same region, the corresponding percentage for 765 Dyaks was as high as 32.4, in spite of the fact that the splenomegaly percentages in the two groups were equal, viz. about 49.

From the foregoing we may draw the conclusion that, although the high incidence of malaria in the inland region certainly has an influence on the frequency of plantar lesions there, this may not be

called the only reason why inland plantar lesions are so much more frequent than in the coastal region, where malaria plays only a minor part. This influence of endemic malaria on the frequency of plantar lesions forms only part of a complex of factors responsible for a yaws endemic. It is even possible that in a region where yaws is endemic plantar lesions are found to be relatively frequent, in spite of a low mean splenic index, and the reverse may also be encountered.

In the light of the foregoing it will be clear that a comparison of the yaws endemic of the inland with that found in the coastal region can only furnish an incomplete explanation of the contrasts noted: the differences between the two regions are so great and so numerous that a full explanation cannot be given in this way. This is not to say that it is impossible by means of the collected data to throw some light on the striking differences between the two yaws endemics.

Below, these differences and the factors which, in the author's opinion, have to be considered in accounting for them, are tabulated. The table needs no explanation, except for the last part, which deals with latent forms.

On page 33 the question of these latent forms has been touched upon; one of the reasons of the relatively high frequency of palmar and plantar lesions inland may be that the number of latent forms and spontaneous recoveries is much smaller in this region than it is on the coast.

If in the coastal region immunity against later yaws manifestations develops more strongly than inland (cf. p. 87 ff.), the number of spontaneous recoveries or latent forms must be higher in the coastal than in the inland region. Furthermore, the number of factors essential to the formation of the most general late forms, or facilitating this formation, are much more numerous inland than in the coastal region. The statement: Whether a person who has been infected by the treponema pertenue will develop palmar and/or plantar lesions depends, in part, on the question whether he or she is periodically infected by the malaria parasite, has a low haemoglobin content, walks much, etc., may, mutatis mutandis, also be made in regard of the latency: Whether a person who has been infected by the yaws treponeme will keep latent yaws depends, in part, on the question..... etc.

Latency depends not only on the degree of immunity but also on a number of non-specific accidental factors.

Coastal region		Inland
5.8 % of the persons examined 13.2 % of the children aged 0—10	POLYPAPILLOMATOSIS	1.6 % of the persons examined 3.2 % of the children aged 0-10
?	Difference between treponema strains	?
Less good	Nutrition of the population	Good
Poor	Nutrition of children	Good
Poor	Sanitary conditions (flies; nature of soil)	Good
Frequent	Portes d'entree (ulcerations)	Not frequent
Slight	Spread of the population	Considerable
Frequent	S. Funicola as a possible vector	Sporadic
Great	Infection and reinfection hazard	Small
Young	Age at which the first infection is most likely	Old [1]
Poor	State of health in children	Good
Long	**Duration of papillomatosis**	**Short**
Good	**Immunity to late forms**	**Poor**
Small	**Number of late forms**	**Large**

9.0 %	PALMAR AND PLANTAR LESIONS [2]	29.0 %
	Factors essential or favourable for the formation of this lesion	
Few		Many
Malayans do not walk much; rice fields close to the kampongs; no hunting. Condition of the soil: extensive sandy and muddy areas; good foads (few stones and tree roots).		Dyaks in this area walk much: rice fields very far away from the kampongs; much hunting. Condition of the soil: latrite, sometimes mixed with sand; if dry, very hard roads (wood paths) in a poor state (very many stones and roots).
Malaria endemic: unimportant. Spleen index: 11.2		Endemic malaria Spleen index 47.0

1.4 %	NODOSITY [2]	8.1 %
	Factors essential or favourable for the formation of this lesion.	
None		None

Sporadic	PINTOID LESIONS [2]	5.5 %
If occuring, confined to hands and feet.		On the legs up to the knees; on the arms up to the elbows.

SUMMARY

In this study a comparison is made between two yaws endemics. From the description of the endemics it is seen that the contagious forms are very common in the coastal region, and occur only sporadically inland. The non-contagious forms, on the other hand, mainly palmar and plantar lesions, are rare in the coastal region and frequent inland. An attempt is made to account for these differences.

The study may be divided into three parts.

a. What factors govern the frequency of the infective form? This question covers all epidemiological aspects of yaws. The discussion, however, mainly deals with those epidemiological factors that have an effect on the duration of the infectious stage. It is very probable that this stage of the disease is of much longer duration in the coastal than in the inland region. This long duration is due to the fact that reinfection is very frequent in the coastal region.

b. The second part gives a review of the non-specific factors that have an effect on the formation of late manifestations, in particular palmar and plantar lesions, nodules, and pintoid forms. It is shown that the non-specific influences favouring the formation of late manifestations are much more numerous inland than in the coastal region.

c. Is there any relationship between the duration of the generalized stage and the frequency of late manifestations? Although such a relationship is difficult to prove, some arguments may adduced in favour of the supposition, that the long duration of papillomatosis in the coastal region increases the immunity against late manifestations.

SAMENVATTING

In deze studie worden twee framboesia endemieën vergeleken. Bij de beschrijving van de endemieën blijkt, dat de besmettelijke vormen in het binnenland zeer veel, en in het kustgebied zeer weinig voorkomen. De niet-besmettelijke vormen daar en tegen, voor het merendeel handpalm- en voetzoolafwijkingen, worden weinig in het kustgebied aangetroffen en veel in het binnenland. Er wordt getracht deze tegenstellingen te verklaren.

De studie valt uiteen in drie gedeelten.

a. Welke factoren beheersen de frequentie der besmettelijke vormen? In deze vraagstelling, ligt feitelijk de gehele epidemiologie besloten. Bestudeerd echter worden vooral die epidemiologische gegevens, die van invloed zijn op de duur van de gegeneraliseerde besmettelijke vorm. Het blijkt nu dat het hoogst waarschijnlijk is dat dit stadium in het kustgebied veel langer duurt dan in het binnenland. Bij dit verschil in duur speelt de reinfectie, die in het kustgebied veelvuldig voorkomt, een belangrijke rol.

b. In het volgende deel wordt nagegaan welke niet-specifieke factoren van invloed zijn, op het ontstaan van late fraboesiavormen, in het bijzonder van handpalm- en voetzoolafwijking, van de nodositae, en van de pintoide vormen.

Het blijkt dat het aantal niet-specifieke invloeden die het ontstaan van

de late vormen begunstigen in het binnenland veel talrijker zijn dan in het kustgebied.

c. Bestaat er een verband tussen de duur van het gegeneraliseerde besmettelijke stadium, en de frequentie waarmede late vormen zich manifesteren? Hoewel bewijzen in dit verband zeer moeilijk zijn te geven, zijn er toch wel een aantal argumenten die het waarschijnlijk maken, dat de langere duur der papillomatosis in het kustgebied, de mensen een betere bescherming geeft tegen het ontstaan van late vormen dan de kort verlopende papillomatosis in het binnenland doet.

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